Power and The Engineer

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MUCH stress is laid upon the performance of engines, and the average engineer takes great pride in the fact that he is able to cut down a fraction of a pound on the water rate of his engine, without giving a thought as to the expenditure of coal in producing the steam.

It is like the man who always thinks twice before he spends, yet makes no effort to earn a better salary in return for his labor.

Good practice demands that attention be given to all parts of the equipment. For the general economy of the plant it should be seen to that the best possible results are being obtained from the boilers.

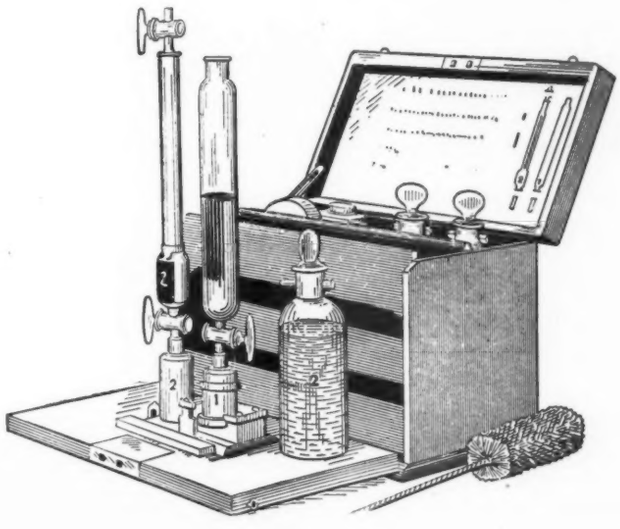
They are perhaps coated with scale. If so, this means a loss in dollars and cents.

When scale adheres to the heated parts, it lessens the conductivity of the plate, hence reduces the efficiency.

This resistance to the passage of heat may become so great that the metal itself becomes overheated and deterioration sets in, thus lessening the life of the boiler.

The expense and time spent in removing the scale are big factors, which should not be overlooked.

In addition scale causes great inconvenience by clogging up valves, blowoff connections and gages; in the latter case, often causing them to read inaccurately.



Scale, then, is an undesirable element, and by all means should be removed. Or better still, remove the cause and prevent the formation of scale.

True, it is not always convenient, nor even possible, to change the source of supply, but the feed water may be treated in such a way as to render it harmless.

Perhaps you have been the victim of some over-zealous salesman who claimed that his compound, like some patent medicine, was a panacea for all the ills of the boiler, and having taken him at his word, with disastrous results, you then and there declared yourself to be through with all water-softening compounds.

All hard waters, however, are not alike, and a solution which will reduce the hardness in one case may have no effect whatever upon another; in fact, it may even complicate matters.

The only way to attain satisfactory results is to tackle the problem systematically.

Have the feed water analyzed by a competent chemist, or send a sample to some reliable manufacturer of water-softening compounds and have a mixture made up to suit your particular case.

It will be found that the cost of treating the water is more than offset by the saving in fuel and labor, not to mention the wear and tear on the boiler.

La Salle Hotel Power Plant, Chicago

By Osborn Monnett

The new La Salle Hotel in Chicago represents the most uptodate practice in hotel construction, embodying all the conveniences and services demanded by the traveling public. The power plant is unusually complete. Five Lyons boilers, with mechanical stokers, furnish a total of 2000 horsepower, and in this connection an approved method of handling coal and ashes is employed. Three generating units, driven by Fitchburg horizontal engines, furnish current at 250 volts, which is distributed by the three-wire system, with a balancer set. Both direct and indirect systems of heating are employed, the former using the exhaust steam from the auxiliaries.

One of the most recent and notable additions to the buildings in the downtown, or loop district, of Chicago, is the new La Salle hotel, situated at the corner of Madison and La Salle streets, in the center of the financial and business district. The building is of absolutely fireproof construction, twenty-two stories high above the pavement and occupies a space of 162½x178 feet. Supported on one hundred and five concrete caissons extending down to bed rock 110 feet below the street level, this magnificent building of steel and concrete, faced with Bedford stone and brick, contains the enormous total of 1172 rooms, furnished with all that modern civilization demands in the way of conveniences, and is one of the finest examples of architecture to be found in the city.

The entire area of the subbasement is occupied by the power plant, which has been carefully designed to facilitate all necessary operations with a minimum of noise and vibration and with special regard to the space available, the result being that there is a notable absence of the crowded condition so often found in similar installations. Light-colored paint has been used on the walls and piping and the cement floor is finished in cream-colored enamel, which, together with the pleasing finish of the silently running engines, makes an attractive combination for the engine room.

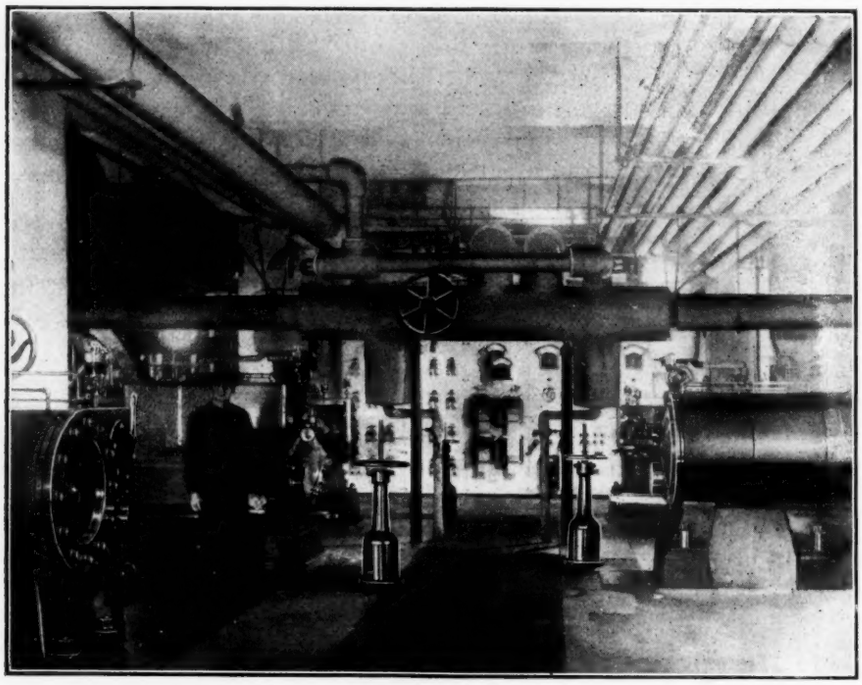


FIG. 1. MAIN OPERATING AISLE AND SWITCHBOARD

BOILER ROOM

The boiler room is built somewhat lower than the rest of the basement and affords the necessary head room for working on steam piping, safety valves and fittings. As may be seen in the general plan, Fig. 2, the boilers face the coal-storage space, making the matter of coal handling a simple one. Two methods of receiving coal are available: one from wagons dumping into chutes, and the other from cars as shown. In the latter case the coal is elevated in a Jeffrey bucket conveyer and distributed to the coal bunkers by a horizontal screw conveyer, the coal being dumped into any of the bins, at the will of the operator. A storage capacity of 175 tons is provided and from the bins the fuel is shoveled to the hoppers by hand.

There are five Lyons boilers, each of 400 horsepower rated capacity and capable of carrying a 50 per cent. overload. These boilers are a combination of the fire- and water-tube types, as shown in Figs. 3 and 4. The shells are of extra-heavy plates with triple-riveted butt-strapped joints, 90 inches in diameter by 18 feet long, with 188 three-inch tubes. At each end of the shell are steel saddles into which 20 water tubes are expanded. Covered with split tile, these tubes form the roof of the furnace and prevent the heat from coming in contact with the plates. The brickwork extends only to the bottom of the saddles and forms the side walls of the combustion chamber, the remainder of the boiler being heavily lagged with 85 per cent. magnesia covering. A working pressure of 160 pounds is carried.

Each boiler is equipped with an improved McKenzie chain-grate stoker, the construction of which is clearly shown in Figs. 4 and 5. Each stoker is independently driven through gears by a 2½-horsepower motor, which arrangement makes it practically impossible for all stokers to be disabled at once as might occur with the usual line-shaft drive.

Another unique feature is the large ash-storage capacity at the end of the grates, permitting a run of several hours without dumping. This has the effect of sealing the bridgewall from air leakage and allowing any hot coals to thoroughly give up their heat before being discarded. The construction of this feature is shown in Fig. 5. When desired, the ashes are dumped into a small steel ash car on tracks in the ashpit, as shown, and pulled to the front of the setting, then elevated into wheelbarrows, by which they are wheeled to the end of the boiler room and dumped into a chute leading to cars in the tunnel. The construction of the boiler and furnace setting is such as to meet the requirements of the Chicago smoke inspector's office, thus making smokeless combustion easy of attainment. The water tubes not only isolate the shell from the hot fire, thereby removing one element of danger in the ordinary return-tubular boiler, but also permit a thicker shell being used than with an internally fired boiler. This also tends toward safety, while at the same time the well known advantages of the fire-tube boiler, of large steam-liberating space, large heat-storage capacity and steady water level, are retained.

A space of 4½ feet is left behind the boilers, which gives ample room for re-

pair work and for the blowoff valves and fittings. Each blowoff connects to a 4-inch extra-heavy blowoff main running in a trench to a 4x7-foot blowoff tank on the boiler-room floor. This connects with a cooling basin 4x9 feet in dimensions, from which a Yeoman's pump discharges the contents to the sewer. Two vertical duplex 12 and 8 by 12-inch Platt feed pumps are located in the boiler room. They take hot water from a 2000-horsepower Cookson open feed-water heater in the engine room. Connection is also arranged so that city water may be pumped direct to the boilers. Extending from the feed pumps the feed lines consist of extra-heavy flanged piping in two stack, which latter is located at the northwest corner of the building. The stack is of steel construction, 9 feet in diameter and 300 feet high, and is fitted with sectional fireproof lining.

Piping

As indicated in the plan, Fig. 2, the high-pressure piping has been carefully arranged to guard against shutdowns. A main 14-inch header extends over the boilers, divided by gate valves into three sections, with a long sweep connection to each boiler, to which is attached a nonreturn stop and check valve. In the engine room a loop construction of steam lines has been adopted. This consists of a 10-inch main, arranged in such a manner that all connections to the steam-driven machinery may be conveniently tapped in, and provided with valves so that by means of the auxiliary connections to the main header any combination required under the circumstances may be obtained. Drainage has been provided for in the runs of main and auxiliary piping and engine-room loop, the condensation being removed by traps and returned to the heater. In addition, Cochrane receiver separators are located at the engine throttles.

The exhaust mains run in trenches in the floor and receive all branches from pumps, etc., terminating in a common expansion tank from which all heating mains radiate. A large connection also extends to the main feed-water heater previously mentioned and to three service heaters where all hot water supplied to the hotel is heated. These heaters are all cross-connected, so that any of them may be used on house-water service or for boiler feed. Opening from the expansion tank on the exhaust-steam system is an atmospheric line extending 300 feet to the roof.

Engine Room

The generating equipment consists of

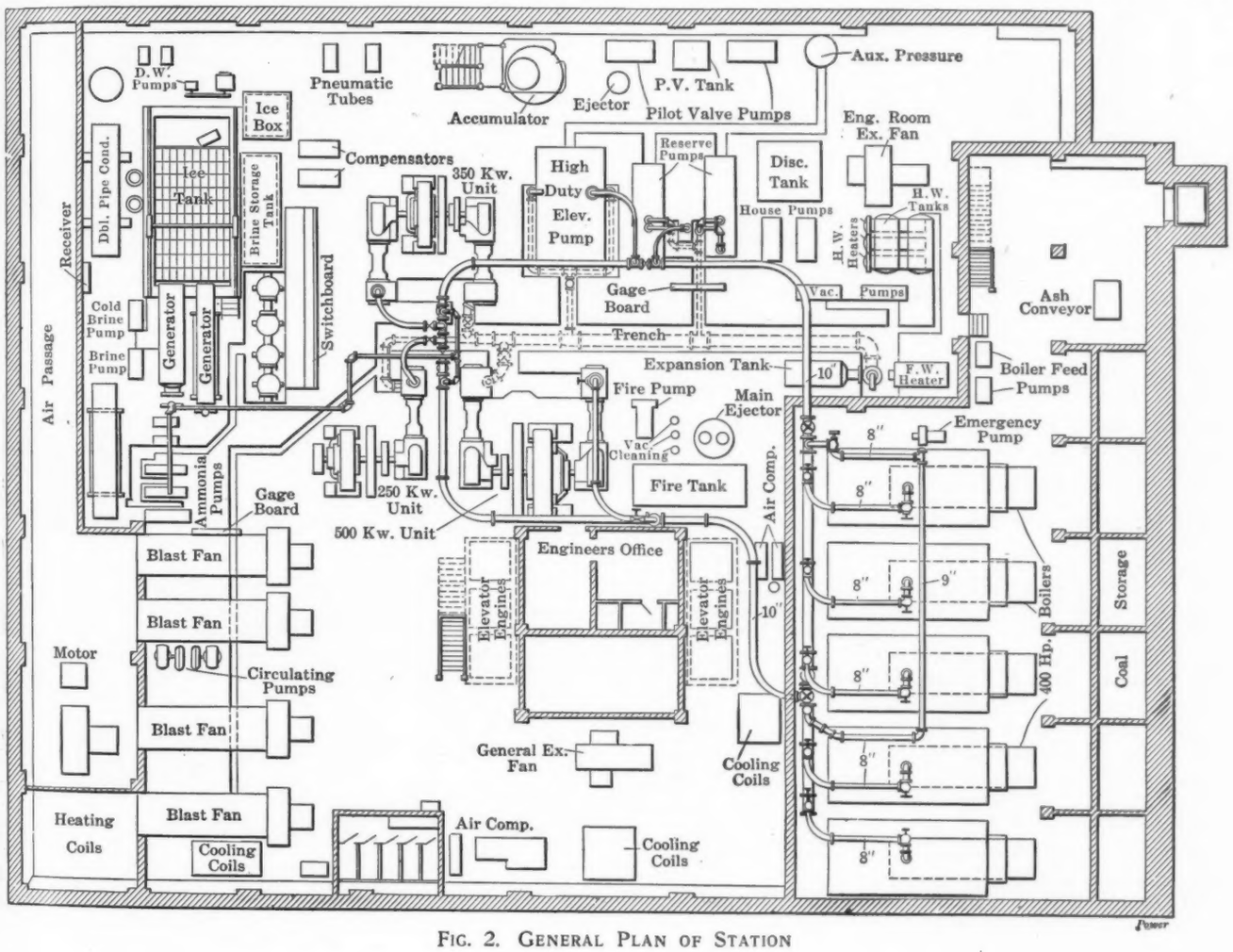


Fig. 2. General Plan of Station

branches, cross-valved so that any section may be repaired without interrupting the feed. An emergency pumping system consisting of a centrifugal pump driven by a Westinghouse steam engine is also located in the boiler room and is held in reserve in case of flooding of the basement by the disability of the regular pumps, or the bursting of a water main.

The flue gases pass to a sheet-steel breeching 3 feet 9 inches high, hanging on rods fastening to the ceiling beams, and varying in width up to the maximum of 13 feet 4 inches at the uptake to the

three Fitchburg engines with balanced, double-ported piston valves, connected to 250-volt Crocker-Wheeler dynamos. One unit is a 20 and 32 by 36-inch cross compound of 500 kilowatts capacity. Another is a 17 and 28 by 30-inch, 350-kilowatt machine; while the third and smallest unit is a 19x30-inch simple engine. Each engine is supplied with an independent Morris oiling system with elevated tank, gravity flow and filters complete. The normal power and lighting load is about 500 kilowatts, ordinarily carried by the large unit. With the two other units in reserve there is ample insurance

against interruption of the service. The total connected load is in the neighborhood of 800 kilowatts, so that the installed generator capacity exceeds the maximum load that may be put on the system. Current is controlled by an 11-

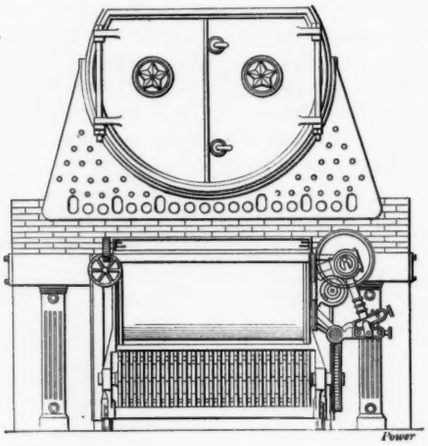


FIG. 3. FRONT VIEW OF BOILER

panel white Italian marble switchboard (see Fig. 1) of the self-supporting, angle-iron-frame type, built by the Western Electric Company. Power is distributed at 220 volts, while the lighting is at 110 volts on the three-wire system, using Crocker-Wheeler balancer sets. Four separate shafts take the feeder circuits to the upper floors.

HEATING AND VENTILATING SYSTEM

All bedrooms and other small rooms are heated by a direct system, using exhaust steam from the engines, and regulated by a Johnson thermostatic control to maintain an even temperature of 72 degrees Fahrenheit. All the large rooms, including dining rooms, banquet halls, etc., are heated by an indirect system; the fresh air being first screened and passed over heating coils located in one corner of the engine room as shown in Fig. 2, and then forced by motor-driven fans to the different parts of the building.

Equally important with the heating system is the system of ventilation. Air in the various rooms is changed according to the uses to which the apartments are put, the average change for the entire building being every six minutes.

In the summer time cool air is supplied to various public rooms and banquet halls in the building, for which a 40-ton refrigerating equipment is used. A duplicate outfit of 50 tons capacity is employed in making an average of 7 to 9 tons of ice daily, and for cooling various ice boxes and refrigerators, the low temperature being maintained by brine circulation. Drinking water, of which 1000 gallons per hour can be lowered 38 degrees in temperature, is also cooled by this equipment. The refrigerating apparatus is located in the engine room and is of the absorption type, of Carbondale manufacture, and operates on exhaust steam at approximately atmospheric pressure.

AUXILIARIES

The pneumatic-tube system for the transmission of orders, letters, etc., throughout the building, is of the Lamson vacuum type and consists of forty-two stations, twenty-four of these stations being located at the floor clerk's desk and different departments, and connected with the manager's office, while eighteen stations connect the kitchen with the service pantries. For operating this system a duplicate set of machines was installed, consisting of two No. 4 Connersville blowers and two 10-horsepower variable-speed motors. The speed of the motors is automatically controlled so that power is consumed only during the transit of the carriers, the system being so arranged that despatching a carrier automatically opens the line and puts it into service and when the carrier is delivered at its proper station the air is automatically shut off and the consumption of power ceases.

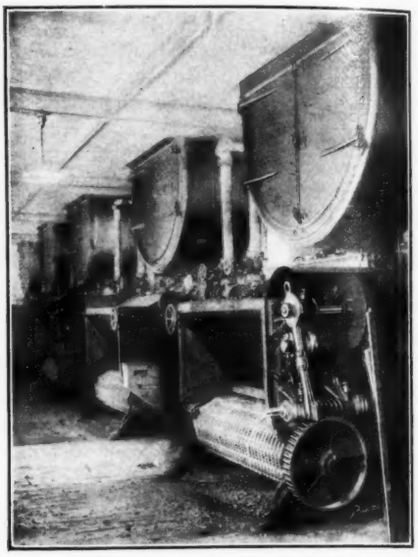


FIG. 4. VIEW ALONG BOILER FRONTS

The vacuum-cleaning equipment consists of three steam-aspirator units, each of sufficient capacity to operate six distinct sweepers at the same time. By an ingenious and yet simple arrangement, when one of these units is taxed to its capacity, the second and finally the third are automatically cut in to supply the needed vacuum to the cleaning tools as they are added, and when their use is discontinued the automatic action is reversed and each unit cuts itself out, the steam consumption being in exact proportion to the work done. This part of the equipment was installed by the

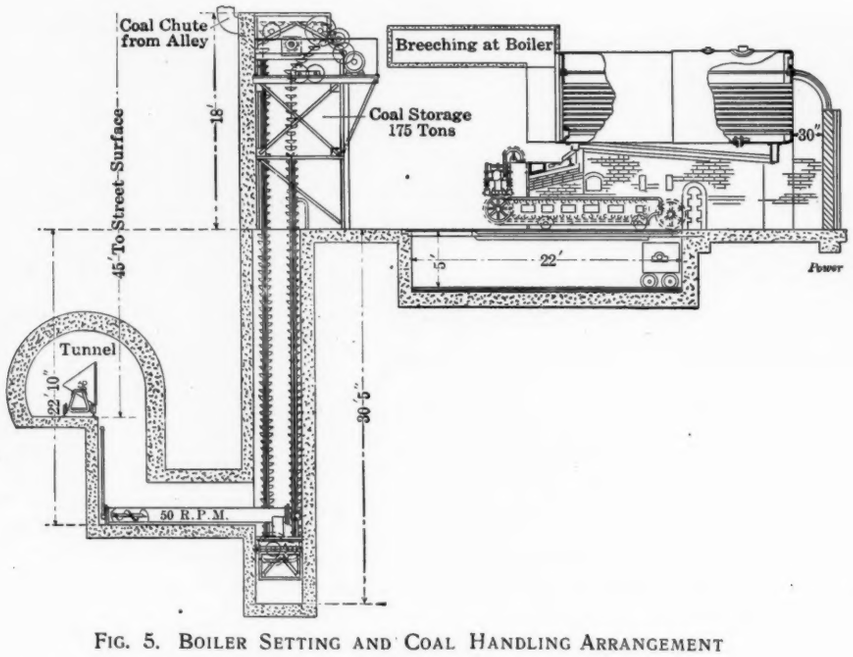


FIG. 5. BOILER SETTING AND COAL HANDLING ARRANGEMENT

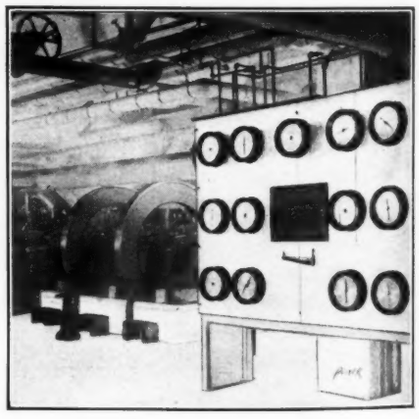


FIG. 6. GAGE BOARD AND ELEVATOR PUMP

American Air Cleaning Company, of Milwaukee, and it was guaranteed that the cost of power to operate it should not exceed 5 cents per sweeper per hour.

Six Otis inverted plunger-geared hydraulic elevators are used for passenger service and three for freight, and ample pumping capacity has been installed in the basement for their operation. The main elevator unit consists of a Laidlaw-Dunn-Gordon three-cylinder compound Corliss pumping engine, with 13, 16 and 16 by 4¼ by 13-inch cylinders. This pump carries the load in the daytime, and during periods of light load either one of two duplex pumps of the same make is used. One of these is a tandem compound, 10 and 16 by 18 by 4⅜ inches in size, and the other a simple 12 and 18 by 4⅜-inch pump, each with outside, end-packed, plunger-type water ends.

Several dumb waiters also form part of the equipment, and are electrically operated. The hoisting machinery for them is of the direct-connected, worm-gear, drum type, with the drum and motor on the same bedplate. The gears operate in an inclosed oil case, designed for continuous lubrication, and the cars are provided with limit stops which prevent their overrunning at either the top or bottom landings. All the dumb waiters are controlled from a panel in the kitchen.

On the twenty-first floor is located the laundry, where all machines are motor driven. There are, in all, eight washers, two mangles, four extractors, a clothes tumbler and other equipment necessary to carry on the work in an institution of this size. Crocker-Wheeler motors are used to drive these machines. A complete outfit of live-steam drying coils is also provided in the laundry run in connection with the building.

In an institution of this kind the position of engineer is an extremely important one and to facilitate his work there has been provided a complete suite of offices, with telephone and pneumatic-tube connections, and every convenience for keeping in touch with the condition of affairs on the many floors above. We are indebted to J. E. Lawrence, chief operating engineer, for the information regarding this interesting plant.

Steam Turbine's Ratio of Accident

In the *New England Engineer* B. S. Farwell recently made the following interesting comments on "Steam Turbine Dangers":

The turbine requires and permits far less adjustment and manipulation than the reciprocating engine—but perhaps for that very reason it receives less intelligent and skilful care.

Its moving parts are all protected by its case, needing to be opened only at long intervals. Meanwhile the engineer can do little more than guess at what is going on inside.

A great merit is the absence of any abrupt change in strain or speed and direction of motion—but the ear misses the sounds which are generally the best evidence of the performance of the engine and the first indication of trouble.

The high speed means, of course, better regulation—but it means, also, less opportunity and shorter warning in case of any derangement of the governing mechanism.

Without the shock and strain of the reciprocating engine, nevertheless, the unprecedented high speed of the turbine not only demands far better workmanship and material than the older type, but it encroaches much further than we realize on the margin of safety. A factor of only 2 to 1 is small enough, and especially when we know that even this is calculated on the highest tensile strength and the best quality of metal, and when we further realize that the strains increase, not directly but with the square of the speed.

While turbines do not store up their tremendous energy in heavy flywheels with their liability to frequent explosions, still their great speed makes them even more subject to disruptive accidents.

According to some figures to which the writer has recently had access there are less than 3000 turbines in service in the United States; but the ratio of accidents of this kind is at least three times that of the reciprocating-engine flywheel.

In a recent explosion near Boston, a broken pin in the safety device of the governor was not observed, or was disregarded by the engineer. In this case the generator end of the engine proved to be the weaker and gave way first.

In a plant at Providence the engineer threw the wrong switch by mistake—the two-inch bolts that held down the casing were promptly twisted off before he could correct his error. With this fast-running machinery there is no time to correct mistakes; one must make the right move the first time.

In New York, on the other hand, it was a failure of the reciprocating engine that sent a current through the turbine, wrecking both machines.

In a large turbine in a Chicago power house a bolt or bit of metal carelessly left in boiler or steam pipe was thought to have been carried over into the turbine blades with disastrous effect.

In Philadelphia the corrosion of the blades and consequent breaking off of small fragments resulted in the destruction of the whole machine.

In Boston the oil pipe supplying the main bearing in some way became clogged with a bit of waste. The oil pressure on the bearing was destroyed and the entire rotor was thrown bodily from its place.

In Los Angeles a surging of the load back and forth between two machines, operating in parallel, culminated in oscillations that the governor could not, or did not control.

In a similar case a large unit where each step of the governor represented in itself nearly 300 horsepower, the sluggish action, or sticking of one step proved to be enough to bring disaster.

Of cource, some of these disruptions were installation accidents and not chargeable to regular operation of the plant, others belonging to the period of experimenting and perfecting new designs and devices.

But the turbine must now be considered as having passed the experimental stage. It will be judged the more rigidly. It must vindicate not only its economy but its safety. While design and type are fixed there is still room for greater improvement in construction, for a still higher standard of material, for proof connection and appliances, for further safeguards peculiar to its own conditions and needs.

The removal of ashes by conveying them to a waste bank hydraulically is done in connection with the temporary plant built to supply power during the construction of the Rainbow Falls hydro-electric development of the Great Falls Water Power and Townsite Company on the Missouri river, near Great Falls, Mont. The power house is on the side of a hill directly above the edge of the river bank. The bituminous coal used is dumped by gravity from cars on a trestle to a bin at the rear of the firing floor of the boiler room, and runs down on this floor, from which it is fed by hand to the furnaces. As the ashes fall through the grate they are drawn out into a transverse concrete-lined trench in the firing floor. This trench is sloped to one side of the building, where it connects with a flume extending on a grade of about 5 per cent. to the edge of the river bank. When the grates are cleaned the ashes are pulled into the trench and a hose stream turned into the latter to start them. They are thus picked up by and carried out in the river through the flume. No difficulty is experienced from clogging in the trench or flume, or an accumulation at the edge of the bank.—Ex.

Uncle Pegleg's Philosophy

It had been a long, hard winter and it did seem mighty good when there came a warm spring day and we could have the wide sliding door open and sit in the sunlight and air. The engine room was up a dozen or more feet from the ground level and I was puzzled to know what that door, opening out into the universe, was for, until I was told by Uncle Pegleg that it was so he "wouldn't have to take the roof off" in case he wanted to get in a half a flywheel or something that wouldn't come in a window or up the crooked, narrow stairway.

They were having a sort of a spring clean-up down in the yard and were using a hose for something or other. The water was turned on unexpectedly, the fellow who was holding the hose was yanked sideways, letting it drop, and it cut up all sorts of antics until they got the water shut off

Any engineer can figure the energy developed when a pressure acts on a moving piston. It is just as useful to know the energy stored in a body moving with a given velocity, as in the jet which drives a turbine. Uncle Pegleg explains how the formula for doing this is developed. Don't shy at the mathematical expressions. There is nothing to it that anyone who can multiply and divide cannot understand and follow.

"Gee!" I said. "There's a lot of power in that thing, isn't there?"

"All the power of the big fire pump," said Uncle Remus. "All the power that the big fire pump can hike up is stored in that stream of water, and it's got to go somewhere before the water will stop moving. And, if if goes twice as fast, it will have eight times the energy, and three times as fast, twenty-seven times the energy. The energy in a stream like that increases as the cube of the velocity. Four times as fast,

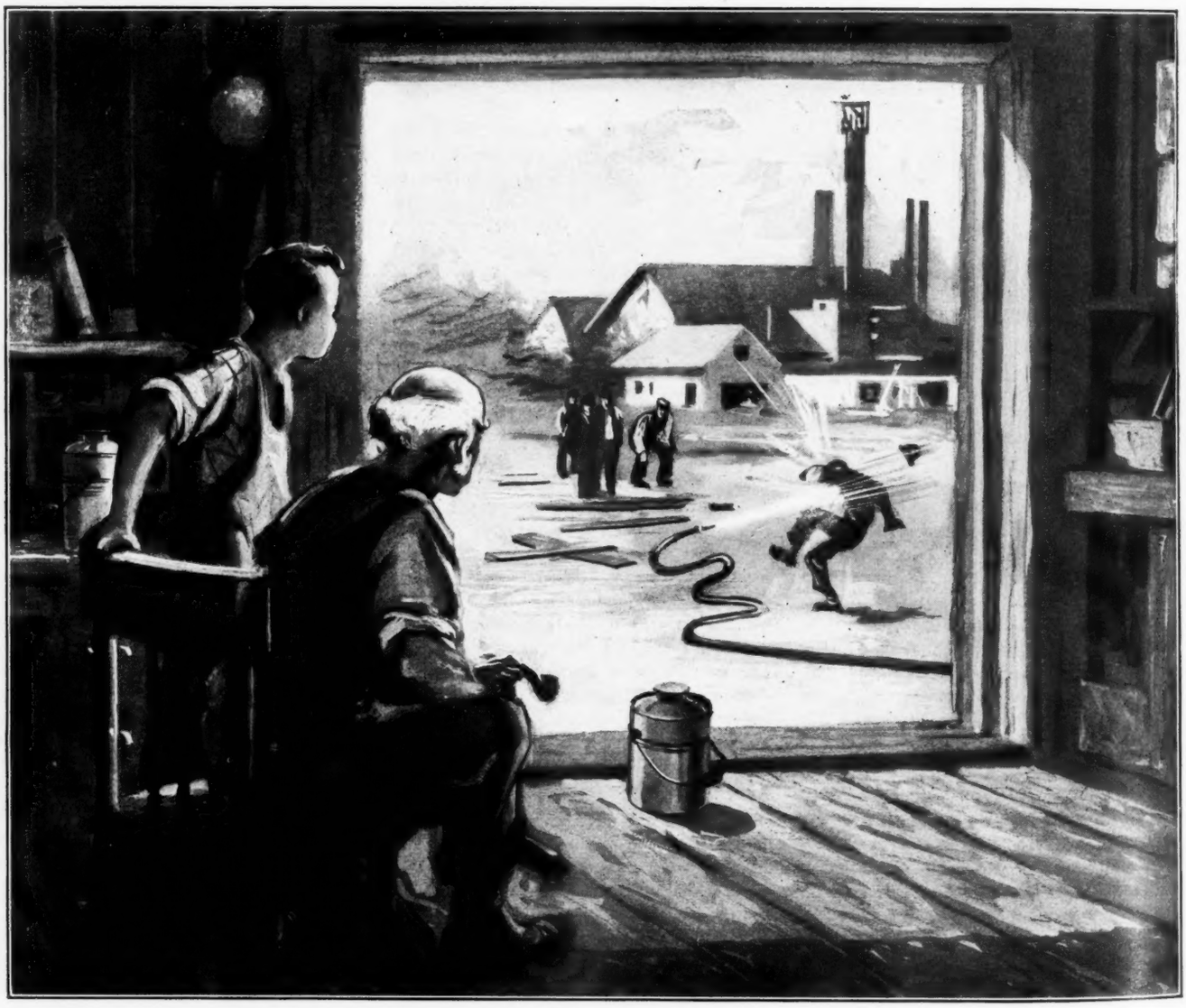
$$4 \times 4 \times 4 = 64$$

times the energy."

"Then the faster you go the better you are off," says I.

"Oh, no. There can't be any energy in the stream that the pump didn't put there."

"But you said if the stream went twice



"GEE!" I SAID, "THERE'S A LOT OF POWER IN THAT THING, ISN'T THERE?"

as fast there would be eight times the energy in it."

"So there will."

"But if it goes twice as fast it will deliver twice as much water in the same time."

"Sure."

"And then the pump will have to run twice as fast?"

"Yes."

"And *only* twice as fast?"

"Ye-e-s," admitted the old man, as he began to see where I was driving him.

"Well, then, the pump has only doubled up on its power and the stream has got eight times as much. How do you make that out?"

Uncle Pegleg puckered up his mouth in the peculiar way that he had when he was puzzled, thought a minute, and said, "You can lay your last dollar on the fact that there is eight times the energy in that jet if it goes twice as fast and we'd better get that clear first because the underlying principle of that will do you more good than almost anything else in mechanics.

"Suppose," he continued, "you had a block of ice setting on a pond and the block of ice and the surface of the pond were so smooth that there was no friction and you pushed on that cake of ice and kept on pushing uniform and regular. The block would slide along slow at first but getting faster every second until in a little while it would be going so fast that you couldn't keep up with it.

"If you pressed one pound *for each pound* of matter in it, the body would gain velocity at the rate of about 32 feet per second. Suppose the block of ice weighed 200 pounds and you pushed on it with an even force of 10 pounds for five seconds, how fast would it be moving?"

He had been working his slide rule as he gave the example and sat looking at me. As I fumbled around at it he said, "First of all, how much force have you got *per pound of ice?*"

"Well," I said, "you have ten pounds of force and 200 pounds of ice so I suppose you have $\frac{10}{200}$ or one-twentieth of a pound of force to move each pound of ice. Is that what you mean?"

"Exactly. Now, if one pound of force will hurry up a pound of matter 32 feet per second, one-twentieth of a pound will hurry it up $\frac{1}{20}$ of 32 equals 1.6 feet per second; and if it gains velocity at this rate for five seconds its velocity at the end of that time will be $1.6 \times 5 = 8$ feet per second.

"Doing this all at once you have

$$\text{vel.} = \frac{10 \times 32^{8} \times 5}{200_{20}} = 8 \text{ ft. per. sec.}$$

or for any other case

$$\text{vel.} = \frac{\text{force} \times 32 \times \text{time}}{\text{weight}}$$

"Notice that the words here correspond to the figures in the example, only the formula shows how to do it for any case where the figures do it for only one.

"If two things are equal and you multiply both of them by the same thing they will still be equal, won't they?"

I allowed that that was so.

"Then multiply the quantities on each side of that equal mark by weight and what do you get?"

I figured out that you would get

$$\text{weight} \times \text{vel.} = \frac{\text{force} \times \text{time} \times 32 \times \text{weight}}{\text{weight}}$$

which canceled out to

$$\text{weight} \times \text{velocity} = \text{force} \times \text{time} \times 32$$

"Good!" said the old man. "Now divide both sides by time and 32. To divide, you know, you write the divisor under the line."

I did this as follows:

$$\frac{\text{weight} \times \text{velocity}}{\text{time} \times 32} = \frac{\text{force} \times \text{time} \times 32}{\text{time} \times 32}$$

"Good again! Then the force necessary to get up a given velocity in a given weight in a given time is

$$\text{force} = \frac{\text{weight} \times \text{velocity}}{\text{time} \times 32}$$

"You can see that it is natural that the greater the weight and velocity the greater the force which will be needed, and so they are the multipliers, but the longer time you have to get up the velocity the less the force can be, so the time is a divisor (under the line).

"Now energy is the product of force and space. If you lift a 10-pound weight 4 feet you do 40 foot-pounds of work because you work a force of 10 pounds through 4 feet of space. What space would a body of a given weight go through in a given time with a given force acting on it?"

"Well, let's see," says I, "the space that it would go through would be the time in seconds times the speed per second, wouldn't it?"

The old man looked on approvingly but expectantly, and I said just what he expected me to—"and we have just found the velocity."

"If you stood up on the roof and dropped a pebble, how far would it fall the first second?" he asked.

"How big a pebble?"

"What difference does it make 'How big a pebble?' Did you ever see a big pebble fall faster than a little one? What is the force that makes a thing fall? Gravity, isn't it? If I hold a 10-pound pebble gravity pulls it with a force of ten pounds or one pound for each pound of its weight. Just the same with a ton or an ounce, if the mass is bigger the pull is just as much bigger, always a pound pull for a pound of mass, so that the pebble, whatever its weight, would have a velocity of 32 feet per second at the end of the first second. Now how far would it have fallen in that second?"

"Thirty-two feet."

"No, no. Think a minute. It would have had to have a velocity of 32 feet per second *all the time* to fall 32 feet and it got this velocity only the last instant. It had no velocity at all to start with. Seeing that the increase was steady, and the velocity nothing to start with, the average was one-half the final. So your pebble would fall 16 feet the first second. See?"

I saw.

"Then the average velocity is one-half the final velocity, isn't it, and this average velocity multiplied by the time gives the space the mass has moved through?"

$$\text{space} = \frac{\text{vel.} \times \text{time}}{2}$$

"Then if energy is the product of force and space we can get the energy by multiplying the values we have found for force and space together, eh?" he continued.

$$\text{force} = \frac{\text{wt.} \times \text{vel.}}{\text{time} \times 32}$$

$$\text{space} = \frac{\text{vel.} \times \text{time}}{2}$$

$$\text{energy} = \frac{\text{wt.} \times \text{vel.}}{\text{time} \times 32} \times \frac{\text{vel.} \times \text{time}}{2} = \frac{\text{wt.} \times \text{vel.} \times \text{vel.}}{2 \times 32}$$

"Do you see how nice that square of the velocity comes in there? This 32-thing is what they call the 'acceleration due to gravity.' It varies a little with latitude so they call it g whatever its real value in figures may be and cutting down energy, weight and velocity to their initials and $v \times v$ to v^2 you have

$$E = \frac{W V^2}{2g}$$

and that is all there is to one of the best formulas in the books."

"But, all the same, the pump only goes twice as fast," I reminded him.

"Yes, I was getting to that. The work that a pump does is the product of the force, working on its piston and the space it works through, isn't it? If we double the speed, and thus the space worked through, we shall only double the work.

But the jet going twice as fast has eight times the energy in it. Then it must be that it takes four times the force to make it do it."

"How do you make it out?" I asked, still unconvinced.

"Well, we have just seen that the energy in the stream is as the square of its velocity for a given weight. If you double the speed there will be $2^2 = 2 \times 2 = 4$ times the energy, and doubling the speed will double the weight so you have again $2 \times 4 = 8$ times the energy. You can't get away from that. That energy has got to come out of the pump. You can't get away from that either. Doubling the speed of the pump, which is all you need do to pump twice the water, will only double its energy per unit of time. The only other thing that you can increase to make up the eight times is the force. The force is the pressure per square inch times the area of the piston. The area of the piston can't change so it must be the pressure that does, and it must be four times as much."

The reasoning was absolute but unsatisfying. I didn't see why the pressure must be quadrupled. The nozzle was the same size and the pressure outdoors, into which the pump was delivering, had not changed.

"All right," said Pegleg, "I've got to look at that belt on the big gang now, but I'll get it into your head tomorrow if I have to take an ax."

Coaling Pier at Hampton Roads

By Warren O. Rogers

The seaboard terminal of the Virginian Railway has pier 1045 feet long and 65 feet wide with capacity of 1500 tons of coal per hour. The entire operation of handling coal is accomplished by means of electrical power.

What is said to be the largest coaling pier in the world is located at Sewell's Point, Hampton Roads, Va., the seaboard terminal of the Virginian Railway.

Fig. 1 is a side view of the pier with two steamers being loaded. The pier is 1045 feet long from the outer end to the bulkhead; the hight at the inner end is 76 feet, and so slopes that at the outer end the hight is about 69 feet. The object of this slope in the structure is to allow the cars to run by gravity from one end of the pier to the other, although electric power is used. The pier, which is 65 feet wide, is constructed entirely of structural steel, with the exception of the approach, which is made of wood.

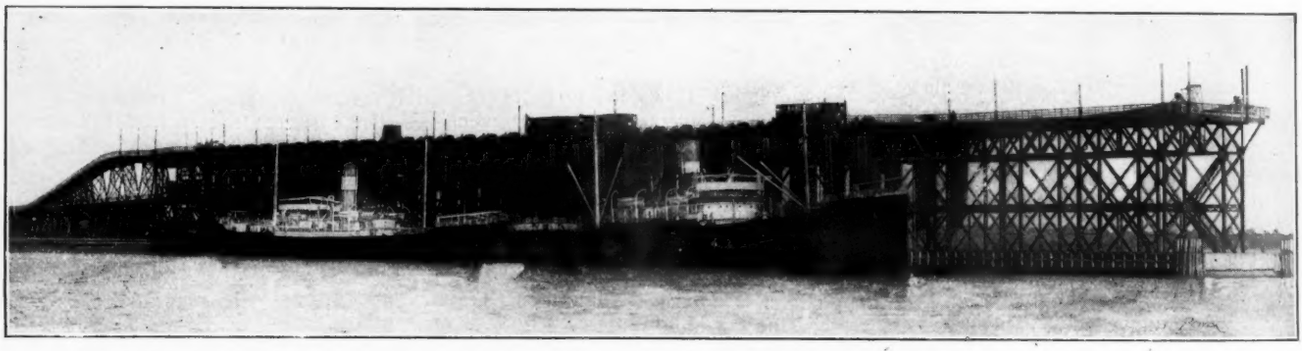


FIG. 1. VIEW OF COAL LOADING PIER AT SEWELL'S POINT, HAMPTON ROADS, VA.

The present capacity of the pier is 1500 tons of coal per hour. The coal is loaded by means of chutes into the hold of the vessels lying alongside the pier, but this capacity can be doubled by the addition of another car dumper. The present car dumper is capable of handling a carload of coal weighing 50 tons every two minutes. An interesting feature of this installation is that the entire operation of handling the coal is accomplished by electrical power. The coal is brought from the mine over the Virginian Railway in gondola cars, this type being used in order that they may be readily handled in the car dumper. The coal is brought in 80-car trains to the outer yard, where the coal is graded as to quality. The cars are then drawn to the inner yard, the various tracks of which are constructed with a down grade toward the car dumper, in order that each car may run to the unloader by gravity. Upon reaching the platform of the dumper the car is seized by a steel gripping arm and the platform, car and load are all tilted sidewise until the car is practically turned bottom side up, or through an angle of 115 degrees. This operation dumps the coal into a specially constructed conveyer car which runs on a track below the dumper.

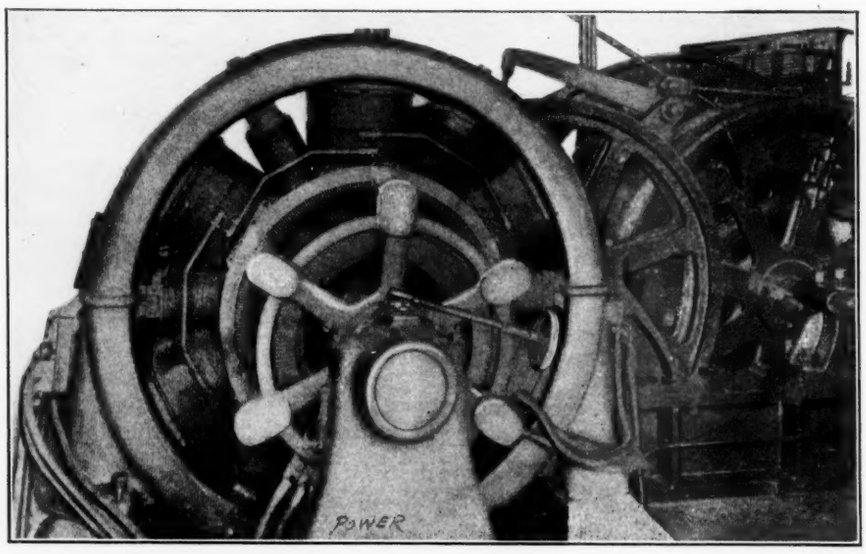


FIG 2. ONE MOTOR OF MAIN HOIST

The empty coal car is started from the dumper by the force of the impact given it as the next loaded car is drawn to the dumper platform. The empty car runs by gravity to the return track, its momentum carrying it up an incline a sufficient distance to enable the car trucks

to clear a spring switch, when the car reverses its direction of travel and returns to the yard by gravity on another track.

There are 10 special steel conveyer cars, all of which are equipped with hopper bottoms, each having a capacity of 60 tons of coal; each car is motor-driven and manned by one operator. The brakes are controlled by air, as are also the hopper bottoms of the car, the current for operating the motors being obtained from an overhead trolley.

After a conveyer car is loaded it is moved toward the incline of the pier by its own motors, passing over an automatic weighing scale, located at the foot of the pier incline.

Leaving the scales, the car passes over what is termed a "barney" car. This car is operated by means of a 1¼-inch cable, which extends to and around the winding drum of the electric hoist. After the conveyer car has passed over the pit in which the barney car is resting, an operator stationed in an operating house from which the electric hoist is controlled starts the motors of the hoist which draws the barney car and loaded conveyer car up the incline to the level of the coal chute. The barney car then returns to its pit and the loaded conveyer car is run to the desired coal chute. There are 62 coal chutes, 31 on each side, each having a capacity of 60 tons. After the car has reached the coal pocket and discharged its load of coal, it returns to its starting place down an inclined track placed between the two unloading tracks.

From the coal pocket the coal is delivered to the hold of the vessel through a sliding hopper and chute, the latter having a vertical range of 43 feet and a side range of 25 feet, which enables the vessel to be loaded with comparatively slight breakage of coal.

The hoist used in drawing the conveyer cars up the incline to the upper deck of the pier is the largest electrical hoist ever constructed and is of the Lidgerwood make. This hoist was mentioned in a previous issue in POWER in an article dealing with large hoisting engines. The entire hoist weighs 180,000 pounds. The winding drum, which is 84 inches in diameter on the winding face, is driven by means of a 116-inch main gear mounted on the drum shaft. On the shaft of the motor is mounted a pinion 21½ inches in diameter, and between the pinion and main driving gear is placed an intermediate gear 72 inches in diameter. The hoist, Fig. 2, is equipped with two direct-current General Electric type MPC motors. One motor is used to drive the hoist, the other is held in reserve. The motors are compound wound and are each rated at 150 horsepower capacity. Their speed is 525 revolutions per minute, and owing to the commutating poles sparkless commutation is obtained. At times these motors are called upon to develop 980 horsepower, as, for instance, while a conveyer is being taken up the incline.

The brake of the main hoist is operated by air under a pressure of 90 pounds per square inch. The brake is mechanically set on the hoist drum by a 1400-pound weight, compressed air being used to hold it in its "off" position while the hoist is in operation. This hoist is capable of delivering 45 loaded cars per hour and of drawing the cars up the incline at a rate of 480 feet per minute, the incline having a 25 per cent. grade, to an elevation of 77 feet.

The hoist for drawing the car to the dumper is operated by a Crocker-Wheeler 200-horsepower motor running at a speed of 550 revolutions per minute. This hoist is operated by remote control from an elevated controller house, which permits the operator to always see the position of the car.

Power for operating the hoisting apparatus is obtained from Norfolk, Va., a distance of 10 miles, through the rotary-converter substation shown in Fig. 3. The current comes in at 11,000 volts, three-phase, 60-cycle, and is stepped down through three air-blast transformers of 550 kilowatts capacity. The current passes through three form P rotary converters and direct current at 550 volts is supplied to the motors on the pier.

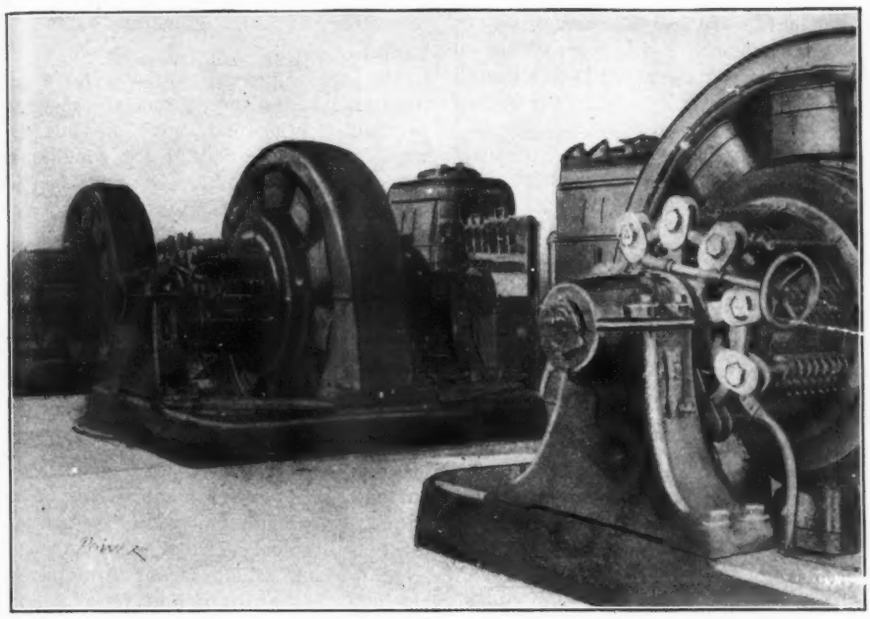


FIG. 3. ROTARY TRANSFORMERS

No Such Thing as Suction in Pump

By S. Kirlin

"Casey," said O'Brien, "Oi've bin thinkin'——"

"Ye don't say!" replied Casey. "Who lint ye th' matherial t' do it wid?"

"That's awl roight, Casey," said O'Brien. "We'll let it pass this toime; but as Oi was sayin', Oi've bin thinkin' an th' subjict av suction, an' Oi've kim t' th' conclushion thot th' aint anny sich a thing as suction."

"Thin," said Casey, "how do yer pump lift wather?"

"It don't lift it," says O'Brien. "Th' air farces it up. Ye see, it's this way: Whin ye stharts yer pump th' supploy poipe is full av air, aint it?"

"Yis," said Casey, "so is some av me frinds, an' it's hot air, too, but Oi won't mintshun no names."

"As Oi was sayin'," continued O'Brien, ignoring the insinuation, "th' poipe is full av air, an' whin ye stharts th' pump it grabbes th' air an' foires it out av th' discharge poipe; this tratement natshurally makes th' air some warm, an' it runs 'round an' thries t' chrawl into th' intake poipe agin; but it foinds th' wather coverin' th' ind av it, so it jumps onto the wather an' thries t' farce enuf av it up th' poipe t' drown th' pump. So ye see, Casey, th' pump has t' work t' throw th' wather out as fast as th' air farces it in. It's jist th' same wid th' pump as t' throw a lazy bum inter a cistern, turn th' wather in on him, an' make him pump t' kape from drownin."

Scale in Boilers and Its Removal*

The article deals with the causes and dangers of scale, giving numerous methods, such as filtration, chemical treatment, applying heat, blowing off boiler, etc., to prevent or lessen its formation. Instructions are also given on how to remove an accumulation of scale and oil.

Scale is the most frequent cause of the minor boiler accidents. This seems not to be generally known to boiler owners, for inspectors find a great deal of scale in boilers, and boiler owners exhibit but little interest when scale is reported to them. Just so certain as scale is allowed to accumulate to any considerable extent in a boiler, just so certain will a bag or rupture of the boiler occur, unless perchance the scale happens to be of a spongy formation, which, however, is not often the case. By the overheating of the plates due to scale, oxidation or "burning" of the metal will occur, reducing its strength and often causing cracks. Overheating will also cause the seams to leak and will loosen the tubes in the heads. The damage done to boilers by unsuitable waters, i.e., by those having a large scale-making content, is enormous.

Scale endangers the safety of boilers in other ways. It clogs the feed pipes and prevents the feed water from entering the boiler freely. It clogs the connections to the steam gage and causes the gage to read incorrectly. It clogs the connection to the water gage and causes it to indicate ample water when there is none at all in the boiler. It clogs the blowoff pipes. Pieces of it get under valves and prevent their closure. A blowoff valve, for instance, screwed down hard and thought to be shut, may allow all the water to leak out of a boiler and cause it to be damaged irreparably.

The presence of scale on the heating surfaces lessens the efficiency of a boiler very considerably, though it is difficult to say just how much. The extent of the loss depends upon the thickness of the scale and also upon its physical and chemical character. The relative effect of oil is far greater.

Causes of Scale

No one process and no one antidote will suffice to prevent all kinds of incrustation. Scale is usually due to one or more of the following causes:

1. Deposition of suspended matter.
2. Deposition of alkali salts by concentration.
3. Deposition of carbonates of lime and magnesia by boiling off carbonic acid, which holds them in solution.
4. Deposition of sulphate of lime, which is more soluble in cold water than in hot.
5. Deposition of other magnesia compounds due to their decomposition in the boiler.
6. Deposition of lime soap, iron soap, etc., formed by saponifications of grease.

The principal impurities in the water used for land boilers are commonly carbonate of lime and sulphate of lime, more or less organic matter, and occasionally sand or clay in suspension.

Prevention of Scale

Scale may be prevented or lessened by:

1. Filtration of water before feeding to the boiler, or use of large settling tanks.
2. Chemical treatment of water outside of boiler.
3. Heating feed water and collecting scale in a heater or purifier.
4. Blowing off the boiler at regular intervals.
5. Use of internal collecting apparatus in the boiler.
6. Chemical treatment or other treatment of water in the boiler.

When a water is bad it is best to reject it altogether if possible and secure a good water. Where this is not possible, the removal of solids from the water and the neutralization of the acids outside the boiler is by far the best course to pursue. Filtration or settling in tanks will remove most of the matter held in suspension, but will, of course, have no effect on the matter in solution. The use of heaters or purifiers, or chemical or other treatment, will be required in the case of the dissolved matter.

In the chemical treatment of the water, the various preventives and solvents may be added to the water previous to pumping it into the boiler, and the precipitates thrown down removed by filtration or settling, or the preventives and solvents may be introduced directly into the boiler.

Trouble due to the carbonates of lime and magnesia is best remedied by the addition of soda ash or tannate of soda to the water. The magnesia compounds form deposits which are most light and porous, so that in general there is but little to fear from them. Carbonate of lime seldom forms a stony scale. It may collect in large masses and do serious injury to the boiler, but the deposits it forms are generally lighter and more porous than those formed by sulphate of lime.

The sulphate-of-lime scale is more troublesome and is much more likely to produce injury to a boiler than a carbonate-of-lime scale of the same thickness. The scale formed by sulphate of lime is hard and adherent, and closely resembles stone. Soda ash and tannate of soda are both of great value in preventing the formation of this dangerous sulphate scale.

The scale preventive that should be used in a boiler should receive the most careful attention and should be selected with especial reference to the conditions. A boiler is one of the worst possible places in which to carry on chemical reactions; the reactions are liable to cause corrosion of the metal. Soda ash, a crude carbonate of soda, is probably the most effective scale preventive and solvent. Being alkaline, it neutralizes any acids that are present. It reacts with sulphate of lime to form carbonate of lime and sulphate of soda. The carbonate of lime, even when it forms scale, is less dangerous, as has been noted, than sulphate of lime, and much of it can be gotten out of the boiler by the use of the blowoff pipe. The sulphate of soda is soluble and will pass out through the blowoff. Carbonate of lime forms a less troublesome scale when soda ash is present than when it is absent, even though no chemical action takes place. The addition of a little caustic soda to the soda ash is often very helpful.

Inasmuch as the scale-forming matter is distributed uniformly throughout the feed water, it is essential for the best results that the preventive or solvent used be introduced in small quantities continuously rather than at intervals in large quantities. It is the practice in some plants to introduce the soda ash or other substance only upon starting up after the boiler has been shut down for cleaning, a large amount of the preventive being put in at this time with the idea that it will suffice until the next periodical cleaning is due. This idea is a fallacy and such use of the preventive is very wasteful and inefficient, for the original charge will have been entirely blown out of the boiler before the time for introducing the next charge comes. It is a good plan, however, when filling a boiler with fresh water after cleaning it out, to introduce a *few* pounds of the soda ash or other preventive at the start. Thereafter, for continuous feeding when soda ash (sodium carbonate, Na_2CO_3) is used, from 2 to 5 pounds per week should in general be sufficient, though the quantity that gives the best results will have to be determined by experiment. The soda ash should be dissolved in water and passed into the boiler by means of a pump or an injector, an attachment to the suction-pipe being provided for the purpose. Where the quantity of dissolved salts in

*From "The Prevention of Industrial Accidents," published by the Fidelity and Casualty Company of New York.

the water is large, scale preventives are not of much use. In such cases the use of the water must be abandoned, or the water freed of the scale-forming matter before it is allowed to enter the boilers.

The use of tannic or other acids, or of crude petroleum, is inadvisable. Tannic, acetic and other acids, attack iron. The so-called "crude oil," in addition to forming a sludge on the heating surfaces, often gives rise to another difficulty, as it often consists either wholly or in part of oil that has been partially distilled, and in such cases the sulphuric acid that is used in the treatment is not always neutralized and may corrode the boiler.

Refined kerosene oil continuously fed in small quantities is beneficial in some instances. The kerosene forms a thin skin of oil on each particle of solid matter and thus prevents the particles adhering closely and forming a solid mass. An automatic sight feed may be used for introducing the kerosene into the boiler. Vegetable oil and greases are exceedingly injurious.

If an open feed-water heater, that is, a heater in which the exhaust steam and the feed water come into direct contact and mix, is used, the introduction of the soda into the heater will often precipitate a large amount of scale-forming matter there, thus preventing it from getting into the boiler at all. In such cases the heater should be well flushed every few hours by the blowoff pipe, and a settling chamber utilized to remove the matter held in suspension in the water.

When soda ash or other solvent is introduced into a boiler in which scale may have formed, the boiler should be opened shortly afterward and whatever scale has accumulated on the sheets removed. Otherwise serious trouble is likely to be caused through the overheating of the metal. The surface and bottom blowoff pipes should also be opened at frequent intervals to prevent the density of the solution from becoming too great, as otherwise priming is liable to ensue. The surface blowoff may be made in the form of a flat cone fixed at the water level inside the boiler and half submerged in the water. This blowoff may also be used in removing any organic matter that may collect on the surface of the water.

The use of a "scale pan" has proved useful in many instances in preventing the disposition of scale on the plates. This is a shallow pan about 4 to 6 feet long and as wide as can be passed through the manhole. It is supported by light legs about 3 inches long and is placed on the firesheet directly over the grates. As the scale falls it is caught by this pan and thus kept off the sheet and prevented from causing the bagging of the sheet. Where such a pan is used, however, it should not be depended upon in the least to the extent of lessening the frequency of internal cleanings and inspections.

Removing Accumulation of Scale and Oil

To rid a boiler of accumulated scale and oil, first empty the boiler (after the steam pressure has died down), and take out as much of the scale as can be easily removed by mechanical means. Then fill the boiler with water to within a few inches of the top and put in about 30 pounds of caustic soda (sodium hydroxide, NaOH) per 100 horsepower, i.e., per about 20,000 pounds (320 cubic feet, or 2400 gallons) of water, and let it simmer for 48 hours (or longer, if possible) at little or no pressure over a very gentle fire. Allow the boiler to cool and blow down thoroughly, then enter the boiler and scrape off whatever scale has remained stuck fast. This process should make the process very soft, but it may harden again on exposure to the air and for this reason the boiler must be cleaned quickly after the water is let out. It may be necessary to repeat this operation several times before the boiler is perfectly clean.

Great care should be exercised in handling the caustic soda. It should not be gotten on the hands and especially should it not be gotten into the eyes. It should not be handled with the bare hands. If it is used, a bottle of dry bicarbonate of soda should be kept in the boiler room to serve in case of emergencies. Then if by any mischance some of the caustic soda gets into anyone's eyes, a handful of the bicarbonate of soda should be put into a wash basin of cold water and stirred up, when the face should at once be thrust into the solution and the eyes opened if possible. The bicarbonate of soda converts caustic alkaline substances into carbonates and has itself no injurious effect on the eyes.

The absolute necessity for the periodical use of the blowoff pipe should not be overlooked. After the scale-forming matter has been precipitated by heat or by chemical action, it remains in suspension for some time, and if the circulation in the boiler is interrupted for some time, as for instance, when shut down at night, or when the fires are banked at the noon hour, the matter will collect mainly where the circulation is least active, namely, at the rear end of the boiler, and may be blown out. The best time to blow out is in the morning before starting up and at the end of the noon hour.

The feed pipes, water-column connections, and blowoff pipes of boilers should be watched carefully and kept clear of scale. If not properly attended to, they will choke up with scale. The same degree of careful attention is necessary also in the case of coil heaters, water grates and water-tube boilers. The most troublesome form of scale is that deposited in pipes exposed to the fire; here it bakes on hard and is very difficult to remove.

Boiler Compounds

The promiscuous use of boiler compounds, fluids, powders, or like substances is inadvisable. Unless their composition and how they will affect the impurities in the boiler water and the boiler itself is positively known, they had best not be used at all. In the treatment of boiler waters it is always best to start with a careful analysis of the water and then have the compound to be used made up accordingly.

Feed-water Heaters

Provided the exhaust steam is at or about atmospheric pressure (which will always be the case with engines run noncondensing) and provided the supply of steam is sufficient, an open feed-water heater will throw down such scale-forming matter in solution as is precipitated at a temperature of 210 degrees Fahrenheit or under.

Water containing carbonates of lime and magnesia, mud, or other substance held in suspension, may be most easily purified perhaps by using the open type of feed-water heater. The main objection to this, however, is the fact that the usual open heater does not remove all the oil from the steam but allows some to reach the boiler. The oil chamber in this design of heater should be large and the makers should guarantee entire removal of oil. A large settling chamber or hot well should also be provided in which may be placed, if desired, a filtering bed of suitable material to remove from the water all the impurities held in suspension. A blowoff of large diameter should be placed at the lowest point in the heater and used every few hours to flush out the heater.

The closed feed-water heater has an advantage over the open heater in that the oil in the exhaust steam cannot mix with the feed water owing to their entire separation. To offset this advantage, however, the surface of the tubes on the steam side may become coated with a film of oil and on the water side with scale, so that the efficiency of heat transmission is decreased. The further fact that there is no means of readily removing the scale from the inside of the closed heater is an obstacle to its use with many waters.

A live-steam purifier may be used to remove the sulphates, as well as the carbonates, by heating the feed water by live steam to a temperature due to the boiler pressure. Sulphate of lime is thrown down at 280 degrees Fahrenheit, corresponding to a gage pressure of 35 pounds. Such purifiers must, of course, be strongly built. In these purifiers the internal arrangement is such that the water drips or trickles over successive pans placed vertically over one another. The scale-forming matter is deposited in these pans and the entire nest of pans may be removed for cleaning. It is well

to supply the feed pump with steam from the purifier, so that the carbonic-acid gas, the air and the other gases given off by the water may be removed. The purifier is placed above the boiler at a sufficient hight to permit the water to drop down to the boiler by gravity.

The open feed-water heater and the live-steam purifier working in conjunction will give the boiler practically pure water, which in turn adds much to the safety of operation.

All open feed-water heaters should be provided with an automatic overflow valve or other arrangement to care for the heater in case the regulating valve for the supply fails to work. Where no such provision is made and the water level in the heater should rise above the exhaust opening, there would be nothing to prevent the flooding of the engine and a probable serious breakdown. Some heater manufacturers recommend that an ordinary low-pressure trap be connected to the heater as a safety valve is to a boiler.

Power Cleaners

These should be kept in motion during their use so that they will not strik an undue number of blows on any one part of the tube. The pressure used should not exceed 20 to 30 pounds per square inch. Compressed air should be used to operate tube cleaners unless the motive power is external to the tube. In case steam exhausts into the tube it should not be permitted to blow through the tubes of a cold boiler long enough to heat them to any extent. Finally, the boiler tubes and heads should be carefully watched during the operation, which should be done by a skilled attendant.

10,000 K.W. Turbine for Kansas City

By Edward H. Lane

The latest addition to the equipment of the Missouri river power house of the Metropolitan Street Railway Company at Kansas City is a 10,000-kilowatt Westinghouse-Parsons, double-flow turbo-generator. The installation with all auxiliaries occupies a floor area of 779 square feet.

While all large turbine installations seem to have a sameness about their descriptions, the turbo-generator recently added to the equipment of the Missouri river power house of the Metropolitan Street Railway Company has a few features which may prove to be interesting.

The turbine is of the horizontal, double-flow, combined impulse and reaction type, having for its first stage an impulse wheel with two rows of blades on it with one row of stationary blades between them. The turbine was built by the Westinghouse Machine Company. The steam, after leaving the inlet valves, is expanded in a set of nozzles from an initial pressure of 170 pounds to about 60 pounds; that is, at normal load when the inlet pressure at the primary valve is about equal to the boiler pressure. From these nozzles, the steam acts on the impulse wheel. Beyond this wheel the blading is arranged according to the standard Parsons design. After leaving the impulse wheel, the steam goes through a few rows of blades and then divides, half of it going through the hollow shaft to one low-pressure element and the other half going to the other low-pressure element. From these it is discharged to the condensers.

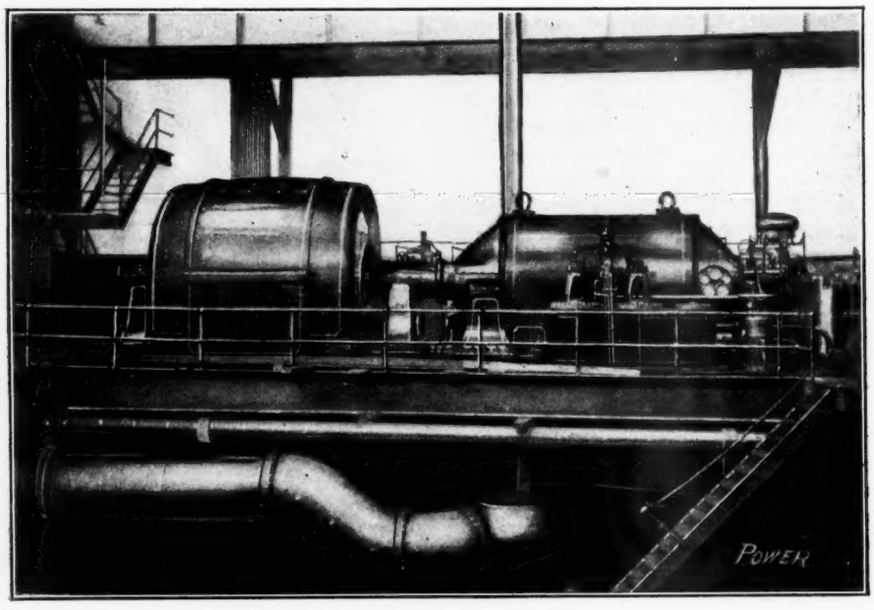


Fig. 1. General View of the 10,000-kilowatt Turbo-generator

The machine has only one dummy piston. It is located just beside the impulse wheel and acts as a packing between the impulse-wheel pressure and the low pressure; in fact, one has to draw on his imagination a little in order to call it a dummy piston at all. The machine is practically without end thrust; what little amount there may be, is taken care of by a thrust bearing of the usual type.

Oil for the machine is furnished by a rotary oil pump, set below the No. 1 bearing. The pump runner is on one end of a vertical shaft; the cam which gives the oscillations to the valve gear is on the other end. This shaft is driven by the gearing which drives the governor. The pump makes 165 revolutions per minute; the governor, 250 and the turbine spindle 1500 revolutions per minute.

The inlet valves are hydraulically operated instead of by steam. The pressure for the operating piston is supplied by the rotary oil pump. The oil goes to the hydraulic cylinder at 45 pounds pressure. The action of the cylinder is controlled by the pilot valve which is actuated by the governor and makes 164 oscillations per minute.

The steam is supplied to the turbine through a 12-inch pipe. It enters through the automatic throttle, and thence it passes through the strainer and the primary valve to the primary nozzles.

In case the load is too great for the primary nozzles to handle, part of the steam goes through the secondary valve to another set of nozzles on the impulse wheel.

In case of overspeed the automatic throttle is tripped by a trigger located at the end of the turbine spindle. There is also an oil relay located on the side of the hydraulic cylinder which is released at the same time and closes the inlet valves.

The foundation for the turbine and generator is a steel structure, under which are located the condensers, the wet- and dry-vacuum pumps, the gland-water pumps and the auxiliary oil pump which is used in starting and stopping the turbine.

The condensers are of the surface, Wheeler, admiralty type. The water en-

ters at the bottom and after passing through three nests of 1¼-inch tubes, leaves at the top, through a 20-inch discharge pipe and enters the bottom of a 30-inch discharge sewer. This bottom connection allows the discharge pipe to utilize about a 10-foot siphon effect, thus relieving the circulating pumps of that much work.

There are two condensers, each having 11,000 square feet of cooling surface. Each condenser has two 42-inch hydraulically operated gate valves in the steam inlet. This arrangement, as well as the 1¼-inch tubes, is necessary on account of the trashy condition of the cooling water which is taken from the Missouri river. One condenser can be cut out and cleaned without making it necessary to take the turbine out of service. The turbine has an exhaust outlet at each end. These outlets are connected to each condenser by means of inverted-Y fittings. An equalizing T connects the two outlets.

The circulating water for the condensers is furnished by a central pumping station situated at the river, driven by induction motors, and discharging into a common 48-inch line which supplies all of the condensers. The condensate is taken care of by two, vertical, two-stage, centrifugal pumps, either of which is capable of handling the condensate due to a 10,000-kilowatt load. The suction pipes are 6 inches in diameter and the discharge pipe 4 inches. These pumps are each driven by a direct-connected induction motor. Each motor is of 15 horsepower capacity and operates on 440-volt, 25-cycle, three-phase current. The dry-vacuum pump is a two-stage machine, driven by a horizontal Corliss engine. The steam cylinder is 8 inches in diameter; the stroke is 24 inches. The air cylinders are each 24 inches in diameter. The pump was made by the Alberger Condenser Company. It maintains a vacuum of 28.5 inches referred to a 30-inch barometer. The generator is of 10,000 kilowatts capacity. The current is three-phase, 25-cycle and of 6600 volts pressure. The generator was built by the Westinghouse Electric and Manufacturing Company.

The space occupied by the entire unit, including all of the auxiliaries except the flywheel-end of the dry-vacuum pump, is 19 feet wide and 41 feet long, or only 779 square feet, which is a low figure for this type of turbine.

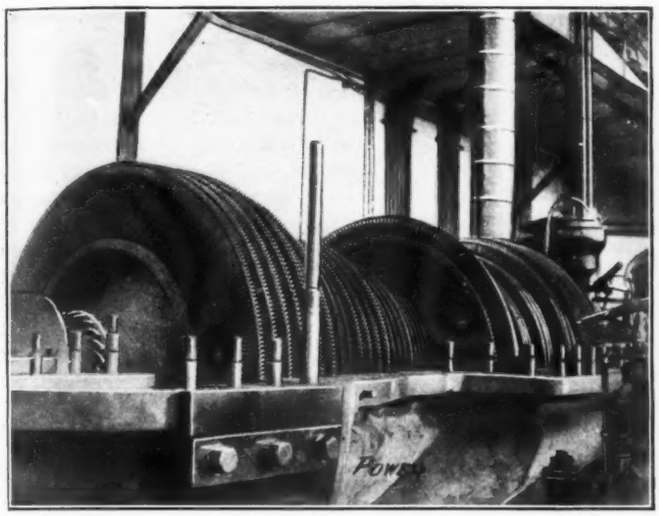


FIG. 2. VIEW OF THE BLADING FROM GENERATOR END

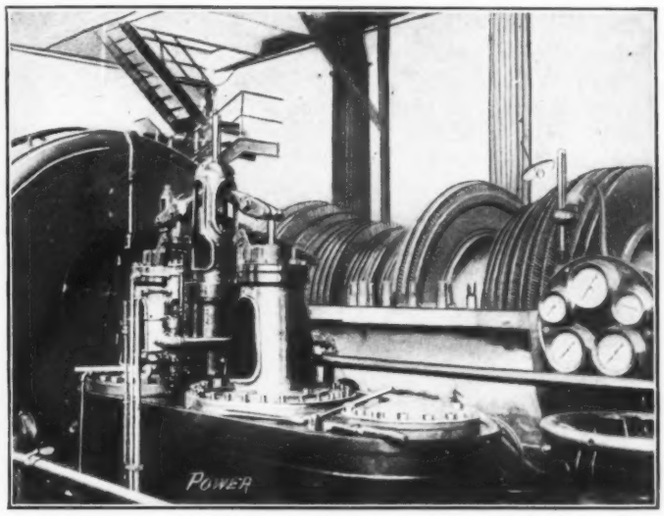


FIG. 3. VIEW OF THE BLADING FROM THE GOVERNOR END

Superheated Steam in Turbines*

The alteration of relative position of parts, consequent on differences of expansion due to variations of temperatures, is materially increased by superheating. This increased difference of expansion between the various parts of the turbine casing and drum from the cold condition to that when at work due to temperature renders larger clearances of parts necessary; and there are further objections, due to the effect of possible variations of superheat. The use of superheated steam, therefore, in turbines containing close-fitting parts, did not seem to warrant the extra risks involved by it, so that the fitting of superheaters received a check. Besides this, the results being obtained in the Parsons turbines with ordinary saturated steam were extremely good.

At present, too, as compared with the early days of low-pressure steam, the difficulties of obtaining adequate superheating are greater. Compared with the practice of forty years ago, the temperature of the steam itself has been considerably raised by successive increases of pressure, while at the same time, by improvement in boiler efficiency, there has been a continued reduction of the temperature of the gases discharged from the boiler. The difference between these two temperatures which is now available for superheating is considerably less than it used to be. There was no difficulty in the old days in obtaining, within reasonable limits, as much superheat as was desired from the gases finally leaving the boiler without any modifications to the latter, which would make it less efficient, and the heat abstracted was so much clear gain. At present, however, this is not possible; the gases are so reduced in temperature by their passage over the normal heating surface that unless special arrangements are made, the excess over the steam temperature is too small to be of much use for superheating.

Superheating with the present-day boilers requires some alteration in boiler proportions or arrangement, in order to obtain such a difference between the temperature of saturated steam and that of the funnel gases in contact with the superheater as will secure sufficient superheating. This modification somewhat reduces their efficiency as boilers.

What seems like a good alternative for large ships has been suggested in the fitting of separately oil-fired superheaters, which would remove the objection noted previously to modifications in design of boilers, the extra space and weight of the separately fired superheaters being compensated for by reductions in the number of ordinary boilers.

*Excerpt from address by H. J. Oram, engineer in chief of British fleet, before the Junior Institution of Engineers.

Electrical Department

A Convenient Lamp Bank for Testing Purposes

By R. H. Fenkhausen

Especially conducted to be of interest and service to the men in charge of the electrical equipment.

Some form of variable resistance adapted for use on any one of the several voltages usually available in any large electrical installation is one of the most useful pieces of shop equipment that could be made. The charging of small, low-voltage storage batteries, and the testing of short lengths of resistance material, etc., as to carrying capacity and temperature, are typical jobs requiring such a resistance.

When breakdown tests are being made on insulation, etc., it is desirable that a resistance be connected in series with the test circuit to prevent excessive current flow in case the insulation should break down.

One of the most common forms of variable resistance is the lamp bank, especially in plants where more elaborate apparatus is not readily available. In its usual form, however, the lamp bank lacks flexibility and except in small capacities is quite bulky. A form of lamp bank which has many good features not usually found in this class of apparatus is shown in Fig. 1. Instead of using regular incandescent lamps, resistance lamps of the type shown in Fig. 2 are used; these are smaller in diameter and make a very compact lamp bank. Each lamp will stand 2½ amperes continuously at 110 volts, taking 275 watts. Forty of these lamps are installed, giving a maximum capacity of 11,000 watts. Four groups of ten lamps each are connected to the blades of four double-throw switches *S*, and each group can be cut in two sections by opening the corresponding switch *A*.

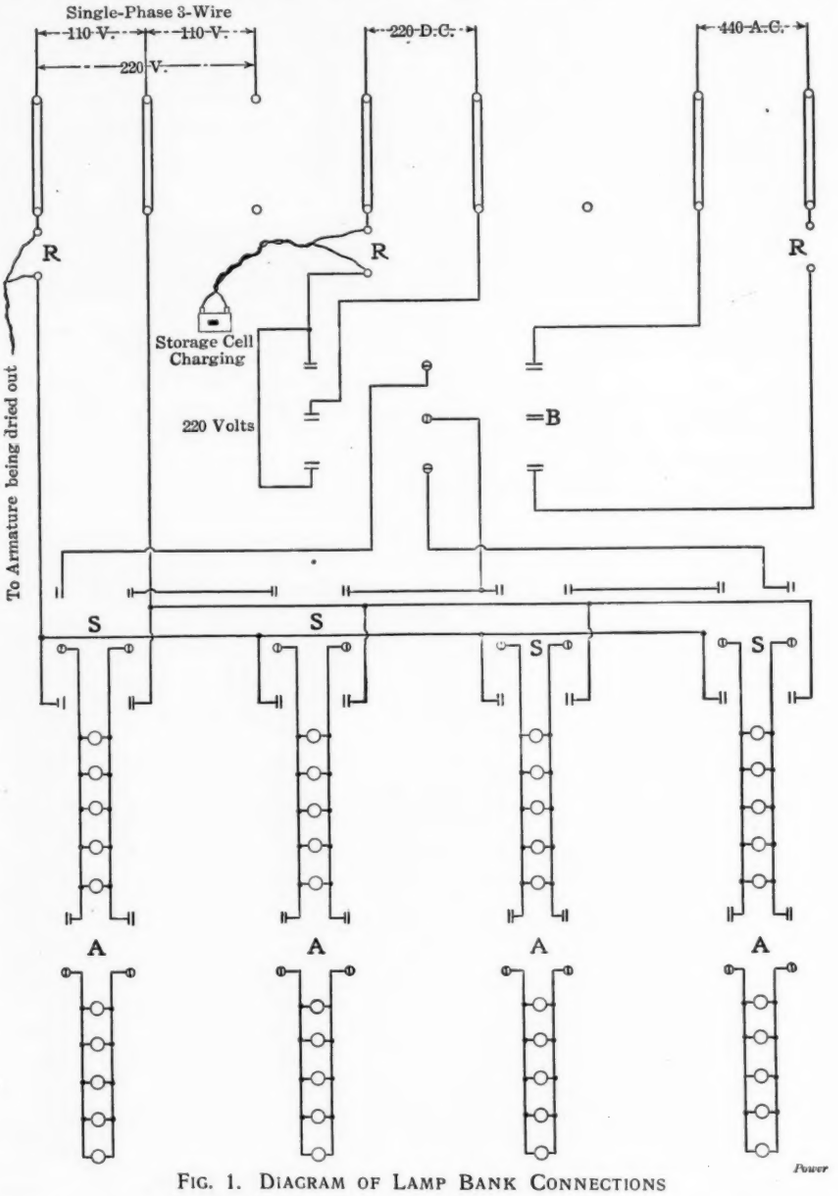


Fig. 1. Diagram of Lamp Bank Connections

The upper contacts of the double-throw switches *S* connect to a set of busbars, which may be fed from either the 220-volt direct-current circuit or from one phase of the 440-volt alternating-current power circuit. The lower set of contacts on the double-throw switches *S* connect to busbars fed from one side of the 110-220-volt single-phase three-wire system. Receptacles *R* are installed on each feeder and by removing a plug and inserting one connected to a twin cable any piece of apparatus desired may be connected in series with any desired resistance on any one of the three voltages.

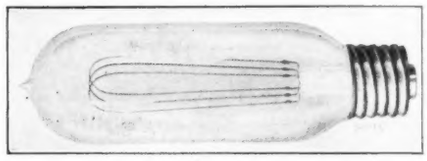


Fig. 2. A Resistance Lamp

For 110-volt testing, from one to all four of the lamp groups are connected in multiple, but when used on the higher voltages either a series-multiple or straight series connection is used.

The switches are so arranged that it is impossible for a careless man to blow up the lamps by connecting them to the higher voltages when in parallel. When the switches *S* are closed downward the groups are in parallel but only 110 volts can reach the lamps with the switches in this position. When the switches *S* are closed upward, there is no possibility of error because the switch *B* which changes the connection from 220 to 440 volts also changes the groups from series-parallel to full series. The only possibility of injuring the lamps by overvoltage lies in the unbalancing of the different groups, but it is an easy matter for the operator to see that all four groups contain equal numbers of lamps before turning on the current.

This bank is also useful when testing out small generators, as loads from 275 to 11,000 watts at 110, 220 and 440 volts may be readily obtained. When 440-volt

tests are being made the whole bank is necessarily in use, but on 110- or 220-volt testing a part of the bank may be in use on each voltage simultaneously.

To illustrate this, the drawing shows a 6-volt 12½-ampere storage battery charging from the 220-volt direct-current mains, and a direct-current armature being baked by passing 37½ amperes through its windings from the 110-volt single-pfiase circuit.

Large Alternators for Norway

By Dr. Alfred Gradenwitz

Five 17,000-kilovolt-ampere three-phase generators, with direct-coupled exciters, were recently ordered from Brown, Boveri & Co., for the Rjukanfos (Norway) hydroelectric power plant. These are the largest three-phase machines so far constructed or ordered in Europe. Each generator, running at 250 revolutions per minute, is to deliver its rated output at 10,000 to 11,000 volts and 50 cycles, with a power factor of 60 per cent. They will be direct-driven by hydraulic turbines, and will be subject to heavy fluctuations in load, and to violent short-circuits.

Four of the machines are designed to run as twin units each having a common shaft and only two bearings. A fireproof partition will be mounted between the two stators to prevent the communication of fire from one to the other.

The guaranteed efficiencies, taking into account all the ventilation and friction losses, are 94.8 per cent. for the twin units and 95.5 per cent. for the single generator, at full load and a power factor of 60 per cent. The variation in voltage with a sudden fluctuation from no load to full load and *vice versa*, is to be 3800 volts for the twin units and 2400 volts for the single machine.

Hydroelectric Development on the Pescara River

The Società Italiana di Elettrochimica at Rome is contemplating the erection of an extensive electrical station for utilizing the water power of the River Pescara in the neighborhood of Torre de' Passeri (province of Terama). The equipment of this plant, which has been entrusted to the Italian branch of Brown, Boveri & Co., at Milan, will include four three-phase generators, each of 8200 to 9000 horsepower (at 6000 to 6600 volts, 42 cycles and 420 revolutions per minute) direct-coupled to hydraulic turbines; two exciter dynamos of 400 kilowatts each (at 220 volts and 600 revolutions per minute), each of which is able to excite all of the alternators; seven single-phase transformers of 3600 kilovolt-amperes each, six of which will form two three-phase sets with the seventh as a reserve.

The transformers will have a ratio of 6000/46,200 or (with constant output) 6600/51,000 volts, and will be insulated for 90,000 volts. They will be connected delta-star fashion, and the linked-up potential difference at the secondary terminals will therefore be 80,000 or 88,000 volts, according to the primary voltage.

The transformers will be provided with oil insulation and cooled by oil circulation. The hot oil will be drawn off from the surface by a pump and delivered to a cooler, through which it will be forced back to the transformer case at its lowest point.

The whole of the electrical energy generated at the station is to be transmitted by a double line, about 125 miles long, to Naples, where it will be reduced at a substation, partly to 5300 volts for the city of Naples and partly to distribution in 27,000 volts for transmission to Torre-Annunziata.

This plant is noteworthy because of its being the first European plant designed for such high potentials.

CORRESPONDENCE

Mr. Weeks' Wagner Motor

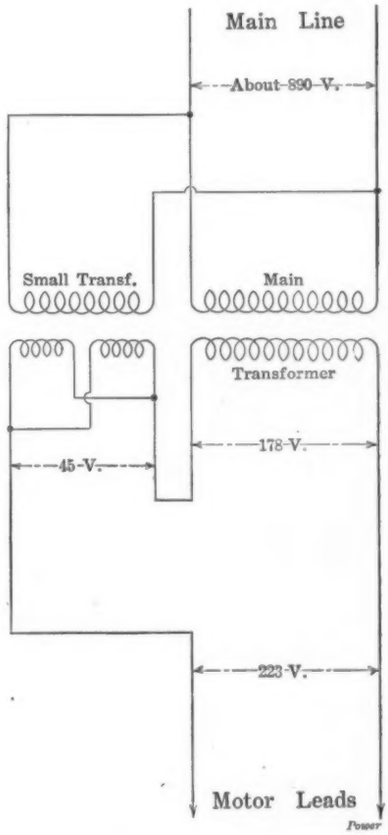
Regarding the trouble met with by Mr. Weeks with his Wagner motor, as described on page 637 of the issue of April 5, I submit the following:

A line 7000 feet long, composed of one No. 6 and one No. 7 wire, presumably hard-drawn copper, would have an approximate resistance of 6.57 ohms. To get 8 horsepower from his motor, assuming a motor efficiency of 80 per cent. and a power factor of 0.75, would require about 10 kilovolt-amperes, which reduced to primary current would give 10 amperes. With this current and the line characteristics the impedance drop would be approximately 67 volts. This would give on the secondary side of the transformer, neglecting any drop in the transformer or the secondary leads, 187 volts, or a 6 per cent. decrease in the terminal motor voltage, about the limit for good performance under load.

Now suppose an attempt were made to get 15 horsepower from the motor, equivalent to about 17 kilovolt-amperes or 17 amperes primary current, there would be an impedance drop of 113 volts, giving only 178 volts at the transformer secondaries, which, supposing the motor would continue to run at somewhere the normal speed, would call for some 90 odd amperes, enough to clear the 80-volt fuses. With such a falling off in voltage, however, and under full load, the motor would slow down sufficiently to allow the governor to drop the brushes.

The trouble could be obviated in several ways: put up more copper, a costly proceeding; increase the voltage of the main generator, which may not be advisable in this instance; there may be additional taps on the transformer so that the secondary voltage can be raised sufficiently to compensate for the excessive line drop at full load; or in all probability there are some extra transformers around the works wound for 1000/100-50 volts and about 5 kilowatts capacity, one of which could be connected as in the accompanying diagram.

With the primary of the small transformer connected in parallel with the large one and the secondary sections of the small one in multiple with each other and in series with the secondary of the



Small Transformer Connected for Boosting

large transformer so that the voltages of the two will be added, there will be about 225 volts at the motor terminals. Various combinations could be tried or the position of the taps changed so that 200 volts could be obtained at the motor. Or the secondary of the small transformer could be connected in series with the primary of the large transformer and boost the voltage on the primary side, but this arrangement would not give as great secondary voltage from the combination. It must be borne in mind that the windings connected in series with secondary of the large transformer must be capable of carrying the full current demanded by the motor.

C. Kerr.

Fort Monroe, Va.

Why Do the Fuses Blow?

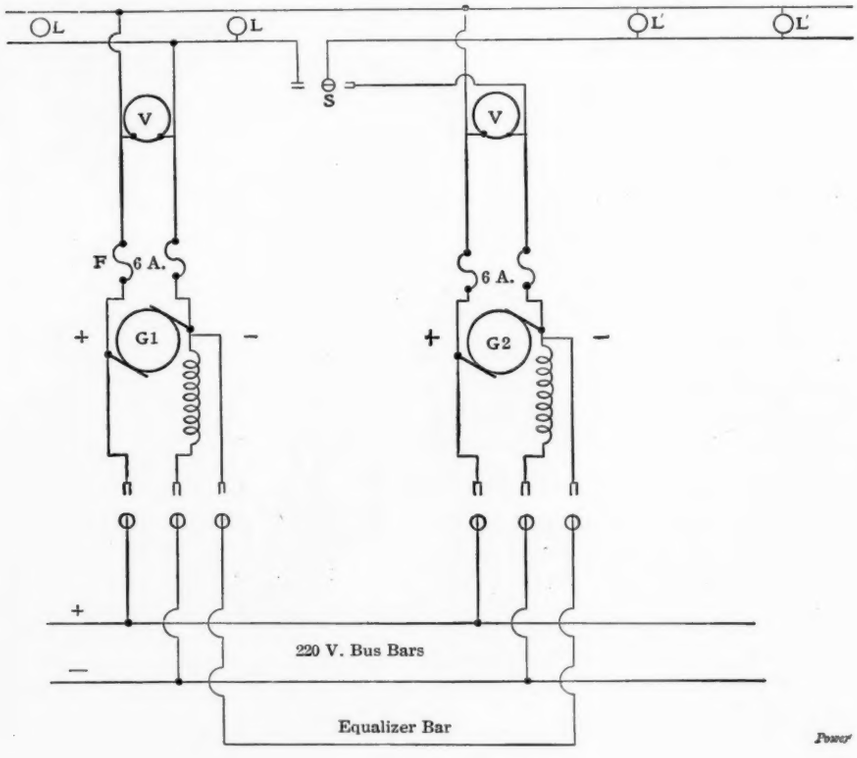
Under the above heading, E. L. Carlton asks for the cause of his fuse blowing, when, under certain conditions he parallels two generators. His diagram is reproduced herewith.

He does not state whether the main switch is a three-blade switch or a two-blade switch with a single blade for the equalizer, which is often the case. In any case the switch is usually so constructed that the equalizer may be closed before the main circuits are closed. Assuming this to be the case, and that the voltage of *G2* was slightly lower than that of *G1* when the equalizer switch was closed (a case which might occur through inaccuracies of one or both of the voltmeters) a circuit would be completed from *G1* through the fuse *F* the upper lead of lights through the positive fuse of *G2*, through *G2* and back to *G1* by way of the equalizer bar. In addition to this current, the fuse *F* is also carrying the current for the switchboard lights, which would account for the fuse *F* being blown while the positive fuse to *G2* remained intact.

If it is necessary to control these lights in this way, I would advise a double-blade double-throw switch to take the place of the single-blade, double-throw switch shown in Mr. Carlton's diagram at *S*. This will remedy all his trouble.

J. M. Row.

Fort Monroe, Va.



E. L. Carlton's Original Diagram

In an article on page 807 of the issue of May 3, E. L. Carlton asks for some reason for the blowing of the fuse *F* in the accompanying diagram (a copy of the one furnished by Mr. Carlton), when the machine *G2* is cut in on the bus-bars, *G1* being already in operation. The machine *G2* is belt driven, Mr. Carlton states, so when first connected to the bus-bars there would be a drop in speed due not only to the prime mover but also to belt slippage, slight in the latter case perhaps, but enough to lower the pressure at the brushes of *G2* sufficiently to cause a small momentary current to pass from the positive side of *G1* through the fuse *F* to *A*, to *B*, to the positive side of *G2*, through the armature and thence back to *G1*. The fuse *F* would therefore have to carry this small current in addition to the lamps, the sum of the two being enough to cause the fuse to blow.

C. Kerr.

Norfolk, Va.

Care of Rotary Converter Collector Rings

I was very much interested in Mr. Richard's article on the care of rotary converter brushes in the April 5 issue, but I wish he had been a little more specific as to the use of the grease on the alternating-current rings—how he applied it and how often.

In the station where I am employed there are seven 1000-kilowatt rotary converters, each having six rings with five brushes on a ring. These have not been taken off in two years. We use engine oil and cylinder oil mixed, and apply it with a felt swab about once an hour during ordinary loads and every twenty minutes during the peak.

The machines sometimes carry 25 per cent. overload.

W. H. Eberhardt.

Buffalo, N. Y.

An Easy Mystery

I had an odd experience with a compound-wound direct-current motor belted to a pattern-shop main shaft from which were driven a wood-turning lathe, a band saw and a circular saw. With the lathe and band saw running free, the motor ran as usual, but when the circular saw was thrown on, the motor reversed, with the usual fireworks, and ran in the opposite direction. Will someone please explain the cause of this?

Herbert B. Brand.

Brooklyn, N. Y.

Repairing Holes in Commutators

If the number of letters published in Power on the above subject is any indication, holes in commutators are a fairly common trouble. In the commutator of a 110-volt 75-kilowatt generator there are several holes, two of them ⅝ to ¾ inch deep, caused by the eating away of the mica insulation. I have tried several fillings, the first being shellac and plaster of paris in the form of a paste. This was better than nothing but did not last long. Then I tried litharge and glycerin. As long as this held there was a higher temperature in the commutator around the hole, showing that the litharge formed a leakage path; but it did not last very long.

Then I tried filling the bottom of the hole with dry plaster of paris, ramming it in tight up to within 1/16 inch of the surface and finishing with a paste of shellac and plaster of paris. This seems to do better than anything I have tried yet, no doubt due to the fact that the shellac dried out better than it was possible for it to do when the entire hole was filled with the paste.

Does anyone know the cause of the insulation being eaten away? Of course, the builders will say that the trouble is due to oil; but if oil is not used on the commutator, what then? And why do not other holes develop instead of the old ones continuing to work deeper? If it is due to oil, why do not holes develop in all commutators on which oil is used?

R. McLaren.

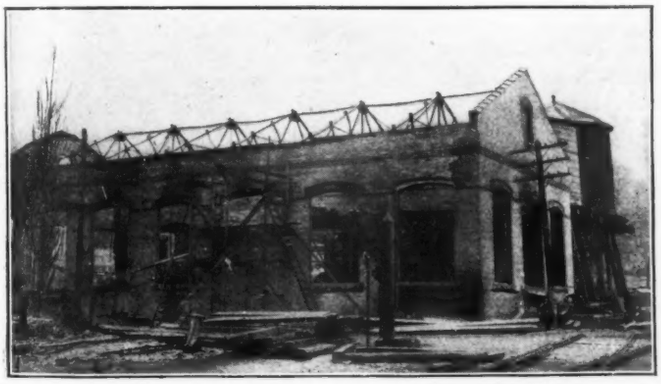
Berlin, Ont.

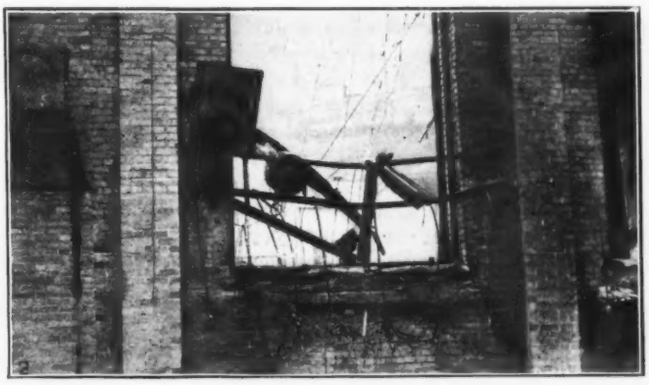
Gas Power Department

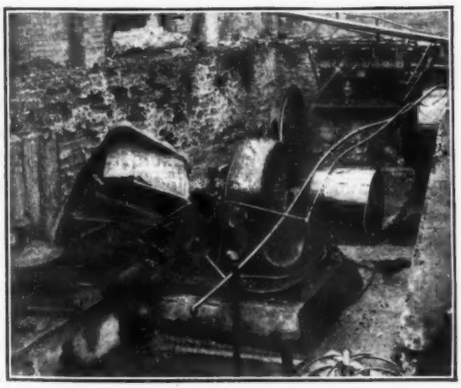
Power Plant Wrecked by a Gasolene Soaked Rag

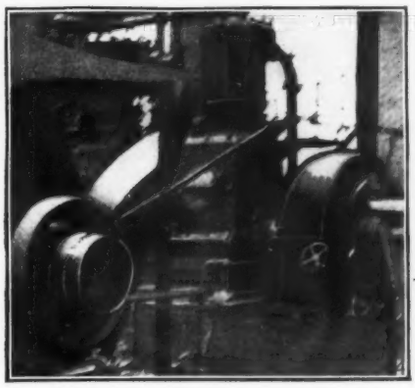
Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men.

The accompanying pictures "point a moral" but they cannot be said to "adorn a tale" in the sense of adding any element of beauty. The fundamental moral which they point is: "Don't monkey with gasolene near an open flame in oil-soaked surroundings." There are several secondary "morals" to be drawn from the occurrence which produced the results indicated by these pictures. "If" an otherwise well built power plant had not had wooden floors, windows and roof sheathing, the pictures would never have been possible; "if" the engineer on duty had utilized the fire-fighting facilities at his elbow, he would not be hunting a job and his former employers would be richer by some $25,000 or so; "if"—but here is the story.









VIEWS OF THE REMAINS OF THE KITTANNING POWER STATION

The power house is that of the Kittanning & Leechburg Railways Company, and is located a mile or so below Kittanning, on the line of an interurban car line for which it supplied the power. It caught fire about 2 o'clock in the morning and, as apparent, everything in the plant that was combustible was completely reduced to ashes within 30 minutes. The fire originated in the basement at the lubricating-oil filter, spread quickly to the main floor, which was of wood and thoroughly saturated with oil, thence to the window and door frames, and finally to the wooden sheathing which supported a slate roof.

Fig. 1 is a picture of the remains of the building. The walls are of brick and the roof trusses of structural steel. These are damaged very slightly.

Fig. 3 shows what is left of a little three-cylinder Westinghouse gas engine in the basement, a Westinghouse generator (in the center) and a station transformer (on the left). Fig. 4 shows the generator end of a 600-horsepower unit, and Fig. 2 is a view of the pathetic remnants of the switchboard.

The station contained two 600-horsepower three-cylinder Warren engines each coupled to a direct-current generator; a twin unit comprising two 400-horsepower two-cylinder engines with an alternator between them; two three-cylinder Westinghouse engines coupled to form a twin unit of 165 horsepower; a generator driven by this latter unit, and a motor generator, comprising a direct-current motor and alternating-current generator, for coupling the direct- and alternating-current systems electrically. All of the engines are vertical single-acting machines, and the fuel used was natural gas. The damage to the larger engines was comparatively slight: melted box linings and a few bent reach rods and minor parts. The cylinders, pistons, rods, crank shafts and main frames were not hurt on any of the engines except the little ones in the basement; those appear to be pretty thoroughly done up. All of the windings, commutators and fittings of the electrical machinery were destroyed beyond redemption, but the frames and cores are not damaged. It is estimated that the cost of putting the machinery in running condition will be $15,000, but it is not reasonable to put the total cost of restoring the whole plant at less than $25,000. Meanwhile, the town is in darkness and the company is buying power from an accommodating neighbor to keep the railway going.

The whole truth as to the beginning of the fire will probably never be known. From the more plausible parts of the several stories told by the two men who were on duty, the officers of the company

have patched together the following: The men were cleaning the upper straining cloth of the oil filter with gasolene, and in some way set fire to the cloth or to the gasolene in the partly empty can; the fire spread to the filter, the top of which was open, because of the cleaning in progress, and thence rose to the floor overhead.

There are two fire tanks of 165,000 gallons capacity and these were full of water; there were also chemical extinguishers hanging on the station walls, but the men said the fire spread so rapidly that they had no time to use the fire hose or the chemical apparatus; it is reported that the one engine that was running at the time continued right along until someone shut off the supply of gas at a valve in the pipe main a short distance from the building.

Horizontal vs. Vertical Gas Engines

By John S. Leese

The problem touched upon under the above caption in a recent editorial is as nice as any before the gas-power world at the present time. Broadly, the advantages claimed by vertical-engine builders for their type over horizontal engines of the same output are higher shaft speed; better balancing and steadier running; less floor space. The first two points are closely connected. The higher rotative speed is mainly due to the ease with which multicylinder engines can be developed, thereby decreasing the stroke per cylinder and consequently allowing more revolutions for the same piston speed. The better mutual balancing possible between the power units allows such speed without undue vibration.

It is hardly necessary to enlarge upon the first point. Suffice it to state that there are large gas engines on the market with five cylinders mounted on one inclosed crank case and with six cylinders arranged in three tandem pairs.

The second point, that of balancing, may not be so obvious at first sight. In a single-crank horizontal engine the only way to balance the revolving masses is by attaching balance weights to the crank webs diametrically opposite the crank pins. Correct balance is well nigh impossible to maintain in commercial work under these conditions. If one could produce a perfectly balanced crank shaft revolving at a high rate of speed in bearings fitted to a frame freely suspended by springs, he would find that there would not be the slightest motion of the frame. But let the shaft be out of balance in the slightest degree and then run up to the same speed. As the speed increased there would be a violent up and down movement of the frame and, speeding up still more, the frame would jump so as to take its weight entirely off the springs at each revolution.

These vertical forces acting in a crank shaft are resisted mainly by the foundation bolts at the crank-shaft end and by the dead weight of that part of the engine structure. In horizontal engines the foundation bolts will obviously have to take care of more of the stresses than in vertical engines, where the whole weight of the machine is symmetrically disposed about a vertical center line which passes through the crank shaft at right angles. Beyond the undesirable up and down tendency in the main bearings is the more important point that the foundation bolts take their hold in the engine foundation and this in turn upon the surrounding earth, which will readily transmit to the walls of the buildings any vibrations that have not been smoothed out by dead weight.

The reciprocating masses of a single-crank horizontal engine are utterly unbalanced. It is only by conveniently compromising with heavy foundations and flywheels that the engine does not go "there and back" each stroke. All forces have equal and opposite reactions and a mean pressure of 80 pounds per square inch acting on a 24-inch piston in a single-acting horizontal cylinder has to be resisted by

$$\frac{0.7854 \times (24)^2 \times 80}{2240} = 16$$

tons, practically, acting continuously at the foundations; or if the explosion pressure be 320 pounds per square inch, 64 tons is the resistance needed at that instant, neglecting the weight of the engine. A foundation must be well laid not to transmit any of this force to the surrounding buildings in the shape of objectionable vibrations.

The forces due to the unbalanced reciprocating parts are, of course, vastly increased in the case of tandem or opposed-cylinder engines, while in double-acting engines the stresses on the foundation are reversed at each explosion. Where horizontal engines are arranged with two opposite cranks the conditions are improved, but vibrations can never be completely eliminated, while complications arise owing to the unbalanced couples which are created as soon as the balancing masses are moved to a different plane from that of the parts they are intended to balance. It is true that these latter forces cannot be eliminated from vertical engines but the conditions are modified in that the foundation (and hence the surrounding earth) takes the stresses in a vertical direction, thus avoiding all tendency to shear the bolts and allowing a much lighter foundation.

The steadier running obtained by the use of vertical engines is due to the ease with which the explosions in their several cylinders can be distributed around two revolutions of the shaft and to their increased frequency with the higher speed. With twin-tandem double-acting horizontal engines working on the two-stroke cycle (not "two-cycle," please), eight explosions can be crowded into a revolution, it is true, but the decreased speed counteracts this advantage and, for the matter of that, four-cylinder double-acting vertical engines can get the same number of impulses into the same revolution working on the same cycle, although the writer is of opinion that trouble would ensue if such an engine were built thus early with the limited experience available. In fact it is a matter for considerable doubt whether, except under extraordinary conditions, double-acting four-stroke vertical engines are worth while when the additional complication in valve gear, etc., is taken into account and when the same results can be achieved by adding more cylinders mounted on the crank case or in tandem.

With regard to the claim for greater economy of multicylinder vertical engines over horizontals, the writer is of opinion that this is hardly consistent with theory or practice although isolated tests may be advanced to substantiate such claims. Cylinders of large dimensions have a much higher ratio of volume to surface than those of smaller dimensions even where the designs approach a minimum of surface. It is generally conceded among theory students that the greater the ratio of volume to wall surface the better will be the economy and that this expectation has been vindicated in practice by the greater economy of large gas engines over their smaller brethren.

In the case of large vertical engines the writer predicts the adoption of open crank cases or frame before long, as marine steam engines are built, together with forced-feed lubrication throughout. Adjustments will be greatly facilitated with this type of frame and all working parts, being easily accessible for inspection, will not be so liable to go long in need of minor attentions as they are at present. Simplicity of valve-operating gear and high-tension ignition will probably be features of the future vertical designs, while a point that badly wants attention is the extension of the platform and handrails to go all around the engine. The plank-like stagings sent out by some makers are both dangerous and inconvenient to work on.

A Correction

The last sentence of Professor Heck's article in last week's issue should read:

"Its compressive work corresponds to the area *G-D-A-H-G* but does not include the work of expulsion, *H-A-E-O-H*."

The symbol letters were inadvertently changed on the preliminary proof by the author.

Readers with Something to Say

Diagrams for Criticism

The accompanying diagrams were taken from a cross-compound Buckeye engine, size 24 and 42 by 36-inch stroke, direct connected to a 500-kilowatt direct-current generator, and located in the power plant of the Pennsylvania & Lake Erie Dock Company.

We gave this engine a complete over-

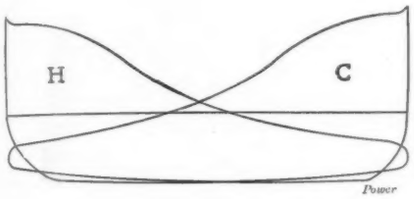


FIG. 1. LOW-PRESSURE DIAGRAMS

hauling and when it was ready for service an artificial load of 1850 amperes at 260 volts was secured by means of a water rheostat.

The high- and low-pressure diagrams, Figs. 1 and 2, were taken. These we

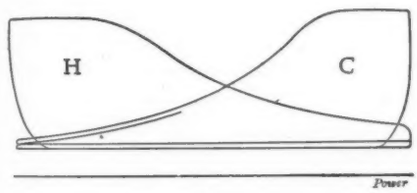


FIG. 2. HIGH-PRESSURE DIAGRAMS BEFORE ADJUSTMENT

thought showed good adjustment of the low-pressure side and accordingly no changes were made.

The high-pressure diagram was not so good. The point of cutoff was later on the head end than on the crank end, and the exhaust was earlier on the head end. We lengthened the cutoff stem and short-

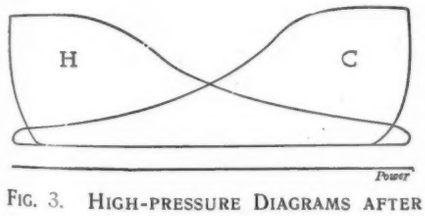


FIG. 3. HIGH-PRESSURE DIAGRAMS AFTER ADJUSTMENT

ened the main valve stem; and after three trials got the diagrams shown in Fig. 3, which showed the events mentioned to be well equalized. The expansion lines conform quite closely to the theoretical expansion curves.

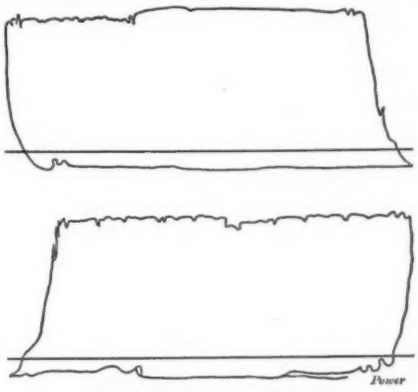
Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words, wanted.

I should be glad for any expressions of opinion from the readers of POWER.

C. D. ELDREDGE.

Fairport Harbor, O.

The accompanying diagrams were taken from a 12 and 7 by 10-inch inside-packed, duplex, Worthington pump. The pressure was 50 pounds. The pump was making about 18 revolutions per minute.



DIAGRAMS FROM PUMP

I would be glad to have POWER readers make comments on these diagrams and offer any suggestions they can for improving the operation of the pump.

H. T. FRYANT.

Jackson, Miss.

Trouble with Hot-water System

We often read of trouble with steam-heating systems but very seldom of hot-water systems. When I took my present position I was confronted with a large hot-water system that had its faults to be remembered by. This is perhaps different from most hot-water systems in that it is in connection with a power plant. The water is heated by two heaters, one an exhaust-steam heater, using exhaust from the engines, the other a live-steam heater which does the work when the engines are not running. The water is circulated by a centrifugal pump driven by a Westinghouse standard engine, this being necessary as the building is quite long, and has wings on both ends.

The main trouble with this system was that on very cold days, with the temperature of the water well over 212 degrees in the boiler room, the expansion tank, located on steel girders close under the roof, would commence to jump, the noise being very annoying in the offices below. This is a closed round steel tank about 3 feet in diameter by 6 feet in length. A relief valve set at 10 pounds is attached to the tank, and the pipe from the valve runs down into a drip pit in the boiler room.

My first work was to put a gage glass on the expansion tank so that I could see what was going on. The normal water level, which is maintained by a trap, I found to be about 12 inches from the bottom of the tank. When the temperature was run up, the water in the tank would rise suddenly to the top and lift the tank off the girders just enough to make a noise—nothing more nor less than a water hammer.

I concluded from this that the cause of the trouble was in the relief valve and accordingly removed the spring and seat, thereby giving the tank free vent down the drip pipe to the boiler room, and have never been troubled with the noise since. We can now run the temperature of the water up to 230 degrees in the boiler room without any trouble.

W. E. HOLT.

Medford, Mass.

The Use of Air Chambers on Pumps

The necessity of an air chamber on a pump for the purpose of softening the shock of the plunger, was brought to our attention by the following experience.

The pump in question was of the triplex type, belt driven, and pumped water to the top of a tower about 125 feet high. We were unable to keep the plunger packing from leaking and the relief valve on the discharge side had a habit of lifting and allowing water to splash over the belt and floor. To save the belt we removed the relief valve, with the result that the joints on the piping began to leak. This necessitated replacing the packing on the flanges every couple of weeks, which operation proved both costly and troublesome.

Finally the remedy in the form of an air chamber was suggested. We accordingly made one from a piece of 6-inch pipe and placed the relief valve at the top. Since attaching this simple air chamber we have experienced no more trouble, and it is still a matter of surprise to me that the manufacturers did not originally supply the pump with one.

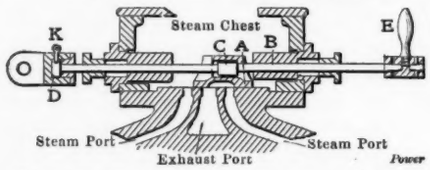
HAROLD JAMES.

New York City.

Converting Compound into a Simple Engine

Being employed by a large pump concern as an expert trouble-hunter, I was called to a large pumping station to determine why their new compound pump consumed twice as much steam as the makers guaranteed. The cause was found to be that the slide valves in both high-pressure cylinders were raised off their seats and caught on the edge of the steam chest, thereby allowing the steam to go directly to the low-pressure cylinder and causing the pump to run as a simple pump instead of a compound. After placing the high-pressure valves on their proper seats and running a test, it was found that the pump performed its normal functions and used the amount of steam guaranteed by the makers.

Upon my return to the factory, I put this experience to valuable use by equipping a compound pump with a suitable arrangement for lifting the high-pressure valves from their seats when desired, allowing the steam to work directly on the low-pressure pistons. This arrangement did away with all outside piping and



SECTION SHOWING ECCENTRIC COLLAR

valves, which formerly had been used when it was desired to use live steam on the low-pressure cylinders. As all engineers know, in some factories where a compound pump has to be used for fire purposes, it is necessary to pipe the steam direct to the low-pressure cylinders in order to get sufficient water pressure for fire purposes, but for daily use, the pump is run compound.

The device used to overcome this difficulty is shown in the accompanying sketch. The high-pressure slide valve is shown at *A; B* is the valve stem; *C* is an eccentric collar on the valve stem; *D* is the round head on the valve stem; and *E* is a coupling.

When it is desired to admit steam at high pressure to the low-pressure steam chest, the pin *K* is first removed and the rod *B* is given half a turn by means of the handle *E;* the pin *K* is then replaced and this holds the eccentric *C* in a vertical position which in turn holds the slide valve *A* up off its seat. This allows steam to flow directly through the exhaust port and into the low-pressure cylinder, thereby changing the pump from compound to simple.

This device gives a considerable saving over the old way of using valves and fittings, and in its simple form, can be readily applied by any engineer.

BERNARD W. POTTER.

Holyoke, Mass.

Lubricating Devices

A short time ago the writer, while visiting a plant in a small town, ran across the following piece of apparatus which seemed to be working very satisfactorily and with a saving of cylinder oil. It also proved to be a time saver as well, as the ordinary cylinder-oil lubricator needs to be filled every four or five hours, while this device requires filling only every three or four days.

This apparatus, as shown in Fig. 1, may be connected to your present lubricator with very little trouble. A piece of 6-inch pipe *F*, 12 inches long and capped at both ends, is connected to the lubricator *A*, Fig. 1, by the two ¼-inch pipes *B* and *C*. The operation is precisely the same as with the ordinary lubricator, the oil flowing from the reservoir *F* to the top of the lubricator through the pipe *B*. As the oil flows from the lubricator its space is occupied by condensed steam which flows to the reservoir through the pipe *C*. In this manner the lubricator *A* is always full and thus a continuous flow of oil to the cylinder is maintained.

In order to fill the reservoir, the valves *D* and *E* are closed, the water is drained from *F* through the valve *G* and oil is supplied through *H*. The reservoir *F* being placed close to the cylinder will keep the oil warm at all times.

Another annoying feature of the hydrostatic lubricator is the clogging up of the feed glass or its becoming dirty so that the amount of oil fed to the engine

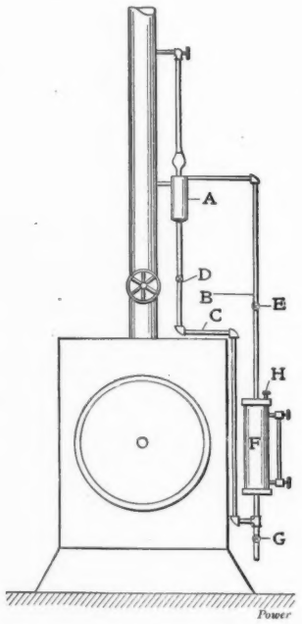


FIG. 1. OIL RESERVOIR ATTACHMENT

is hard to determine. There are several ways in which this may be temporarily avoided. One is to fill the feed glass with a solution of salt and water, while the other is by the use of glycerin in the glass. Both of these solutions will in time become weak and run off into the cylinder with the oil, leaving the lubricator in no better condition than before. A short time ago we began using a heavy oil with the result that it was practically impossible to keep the feed glass clean, so I tried the following scheme which has given good results so far.

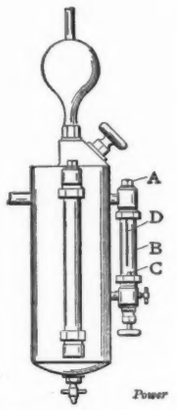


FIG. 2. SHOWING WIRE IN FEED GLASS

Referring to Fig. 2, the plug *A* on top of the feed glass *B* was removed and a small piece of copper wire about 1/64 inch in diameter was soldered on the bottom of the plug. The wire was cut to the proper length so that when the plug was in place the bottom end of the wire was about ¼ inch from the nozzle *C*. The result was that as the drop left the nozzle *C*, it came in contact with the wire *D*, which conveyed the oil to the top and thence to the steam pipe in the usual manner, leaving the glass clean and free.

E. S. LIBBY.

Chicago, Ill.

Check Valves

In a four-story building, the three upper floors of which are used for manufacturing purposes and the lower floor for stores, the upper rooms are heated by large coils running around three sides of the rooms. The system is a two-pipe gravity return with a gate valve on the steam line and one on the return for each floor. We experienced considerable trouble from the pipes filling with condensation and had many complaints for lack of heat. In every case we found the fault to be due to somebody having opened the steam valve and failed to open the return. To make the system "fool proof" I took out all of the valves on the return end of the coil and replaced them with swinging check valves.

Since doing this the system has worked very satisfactorily and now if the tenants want heat they have only to open one valve, and close it again when less heat is desired. The check valve works automatically. This experience may be of benefit to some brother engineer who has had similar trouble.

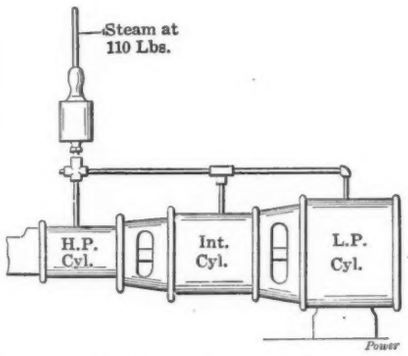
J. R. WILD.

Cambridge, Mass.

Cylinder Lubrication

Some trouble was experienced with a set of triple-expansion pumps of the tandem type, carrying a steam pressure of 110 pounds, and working against a water head of 200 feet. There were two pumping stations having like equipment, one being operated with little or no trouble while the other was a source of constant trouble. The engineer from plant No. 1 was called upon to help locate the trouble in plant No. 2, and upon arriving found the connections from the cylinder lubricators as shown in the illustration, there being a common connection to all cylinders regardless of the pressure carried. Hence, the low-pressure cylinder was getting all the cylinder oil while the high-pressure and intermediate cylinders were running dry, which condition caused the pump to work hard.

In plant No. 1 the arrangement was different. The lubricator was connected to the high-pressure steam pipe, and this allowed the oil to enter the high-pressure cylinder and become thoroughly atomized with the steam, then passing through the intermediate and into the low-pressure cylinder.



METHOD THAT FAILED

After changing the lubricating system in plant No. 2 to conform to that of No. 1, no further trouble was experienced and much less oil was used than before.

C. R. McGAHEY.

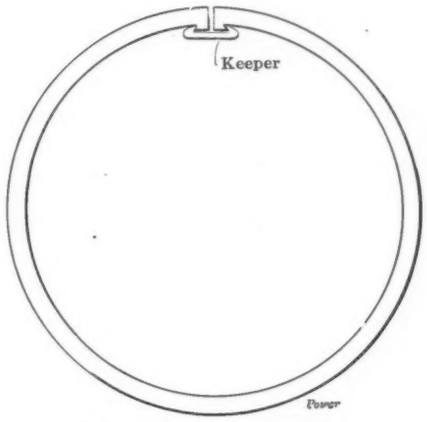
Sheffield, Ala.

Piston Ring Troubles

Vertical engines sometimes make a disagreeable noise in the cylinder, which, in a case coming under my observation, seemed to be caused by the vibration of the piston against the cylinder walls. I could never detect any unusual wear either on the cylinder, piston or rings, from operating while the noise was going on. But the noise became so unbearable that remedies had to be applied.

I found that the only cure for the noise was to use springs of sufficient strength, behind the rings, to steady the piston during the time steam is admitted to the cylinder. The impact of the high-pressure steam against the piston seemed to be the cause of starting the vibration. The low-pressure cylinder of the same engines gave little or no trouble.

The most satisfactory ring for that kind of service was a plain ring of even section with a straight cut through it, the ends being held together by a keeper, as shown in the illustration. The rings were adjusted in the cylinder with the keeper



RING HELD BY KEEPER

slightly loose after the springs were in place. The rings and cylinder then wore to fit each other, and ran for a long time with very little wear. When wear did occur it was an easy matter to file the keeper.

A. G. WRIGHT.

Omaha, Neb.

The Steam Separator

There seems to be a misunderstanding as to the purpose of a steam separator. Many engineers consider it a safeguard against bulks of water coming over from the boiler and when the separator fails to prevent this water from reaching the cylinder, it is classed as unreliable. The true function of the separator is to remove entrained moisture in the steam, due to boilers making wet steam or to condensation in the piping. This water reaches the separator in the form of spray and is removed by baffles or by a sudden change in the direction of flow.

It is common practice to place the separator in the delivery pipe to each engine, just above the throttle. Thus located, it is in position to remove all condensation right up to the throttle, and is convenient for cleaning and inspection; and by selecting one of ample size it will act as a steam reservoir, lessening the effect of cutoff on the header and reducing the tendency to lift the water in the boiler. If placed too far from the engine it will only partly protect it from condensation in the piping.

The boilers should be equipped with dry pipes which will remove the initial moisture in the steam and relieve the separator of this portion of the work. The steam header should drain away from the boilers and terminate in a drip leg which is connected with the drainage system. The delivery pipes should connect to the top of the header, which will prevent condensation from draining into them.

Unless the separator is properly drained it becomes useless, and, in fact, a source of danger, as it may become filled with water which will be carried over into the cylinder. The separator should be drained to a trap or to a drainage system connected to a drip tank, from which it is trapped or pumped to the feed-water system. Large plants have drainage systems, including all separators, drip pockets, etc., returning the condensation to the boilers by means of steam loops or pumps. The drain pipe from the separator should be of such a size that the formation of scale on the interior will not seriously affect its capacity.

The writer is not an advocate of using large steam traps on small drips, because if the valve opening is unnecessarily large it will be opened only slightly and will wire-draw the steam, whereas with a small trap the valve would be given greater lift, thus allowing a larger opening for any sediment to pass out. The separator should be equipped with a gage glass which should be kept clean and frequently inspected. The trap should also be occasionally inspected to prevent its becoming stopped with sediment.

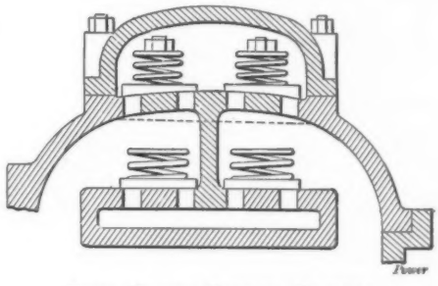
The separator is a safety device and should be treated as such, yet it is often found in inaccessible places, improperly drained and indifferently cared for.

L. C. REYNOLDS.

Willard, N. Y

Some Pump Repair Kinks

It often happens that steam pumps give trouble on account of excessive lost motion in the valve gear. This occurs in the rocker-shaft bearings, valve stem, link heads and pins. Frequently the lost



DECK PLATE DISHED UPWARD

motion becomes so great through wear of these parts that in the case of duplex pumps the valves fail to move far enough to open the ports, and the pump refuses to operate. A certain amount of lost motion is essential to the proper working of this type of pump. It permits the

valve to hang while its operating crosshead moves some distance before the valve begins to move. A little thought will make it clear that if there was no lost motion allowing this hang, the valve would open too early, and the movement of the piston on that side of the pump would be reversed before it could make a complete stroke. This would mean that the volume of steam in the cylinder represented by the uncompleted part of the stroke would be wasted, and the effect would be the same as if the pump had been designed with clearance equal to one-fourth or one-third of the stroke.

This arrangement also accomplishes another desirable end, in that it allows the water valves to seat easily and without slamming, as would certainly occur if the piston had its motion instantly reversed. But while this lost motion serves good purposes, we can get too much of it. If it becomes too great the valves do not get enough travel to open the ports properly and as a result trouble begins.

In one plant of which I had charge, the parts of the valve gear had worn so that the lost motion which had been provided by the designer had to be taken up, and yet the lost motion in the parts became so great from wear that the pump gave considerable trouble. In this case I used bushings in the rocker-shaft bearings and inserted larger pins in the link-pin holes, and in this way put the pump in as good operating condition as when it was new.

The illustration shows another troublesome proposition, but in this case it is in the water end. It will be seen from the cut that the discharge-valve deck plate is dished upward, and, as there was no provision for holding it down by means of a bolt, as is usual, the making of a gasket for the joint between this deck plate and the suction-valve chamber was a rather difficult proposition. What we did was to make two full-sized gaskets from woven asbestos with 1/16-inch wire insertion; between these were placed two thicknesses of red sheet packing ⅛ inch thick and the center built up. The chest cover was screwed down upon it and it gave good service.

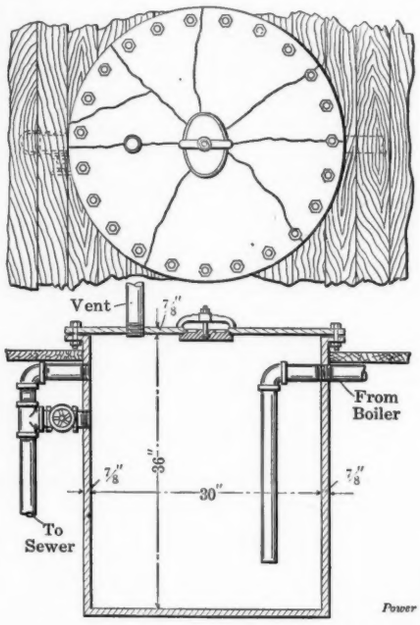
In this same plant there was another pump which had not been used for some time. It had quit work and had never again been put in operation. After going over the valves to see if they were correctly set, I turned steam into it, and the pump would not operate against the boiler pressure at all, but would work as long as the bleeder bypass was left open. After allowing it to run for some time, I examined the valves again and they appeared to be all right. I then opened the steam cylinder and removed the piston rings, and found that someone had tried to spread them by peening on the inside with a hammer which had kinked them badly. As I did not like to operate a plant where 24-hour service was required with only one boiler-feed pump, I lined down the rings with a file, and obtained a good steam-tight fit in much less time than would have been required to get a new set of rings.

WILLIAM WESTERFIELD.

Lincoln, Neb.

Accident to a Blowoff Tank

The cover of a blowoff tank in the boiler room of the Hotel Baltimore, Kansas City, Mo., blew off one day early in January. No particular damage was done. The guests were worked up a bit, however, by the report that a boiler had exploded.



CONSTRUCTION OF BLOWOFF TANK

The sketch shows the construction of the tank, which was made of cast iron. The blowoff, sewer and vent pipes were all 2 inches in diameter. Several pieces of the broken cover showed old cracks extending from the bolt holes out to the edge. The boiler being blown down at the time of the accident had 110 pounds pressure.

E. H. LONG.

Kansas City, Mo.

Remedy for a Hot Box

In spite of the fact that every engineer sooner or later meets with the inevitable hot box, I find that very few know just what to do when such a contingency arises.

It has been my experience that the tendency of a bearing to heat may be remedied very easily, by a simple means which I shall describe.

My first case was that of a small Atlas engine. The tail bearing had long given trouble and I found upon starting up that it heated rapidly and remained at the high temperature during the rest of the day in spite of all the oil that was applied to keep it cool. At the first opportunity I made an examination and found that the babbitt had been started, the oil grooves obliterated and the shaft polished as smooth and bright as the surface of a mirror. Oil or grease would not stick to this surface and could be easily wiped off, leaving the surface perfectly dry.

From the latter observation I concluded that at some previous time the bearing had been run hot through want of oil, and that the excessive friction had polished the shaft until its capacity to carry oil around with it had been destroyed. It occurred to me that if I should roughen the shaft, it might run cool and I accordingly resolved to try the experiment.

With a very fine mill file I went over the smooth surface, applying just sufficient pressure to remove the glossy appearance. This operation I followed with a fine emery cloth which had had its cutting edge removed by previous usage; at the same time making provision for keeping the emery and filings out of the bearing, by packing waste around the edges of the babbitt.

I then started the engine as slowly as possible and gradually increased the speed. The bearing heated up considerably at first but soon began to cool off and kept getting cooler for several weeks after the experiment, and has never since caused any further trouble.

I have used this means a number of times since, and have been successful in all cases except one. In this particular case the trouble disappeared for only a short time and then the glossy appearance of the shaft returned. After trying my first remedy several times without permanent results, I resolved to try something more drastic. I therefore took a very small cape chisel and cut longitudinal grooves in the shaft about 2 or 3 inches apart and to within an inch of the ends of the box, and followed this with the file and emery cloth as before, being careful to remove the burs and sharp edges from the grooves. Upon starting up, the bearing heated rapidly for a time but soon cooled down to normal.

I would not recommend this latter expedient except in very severe cases, because I have not used it often enough to be sure of its efficiency. The first, however, I find perfectly safe and in most cases effective.

Most engineers would have scraped the babbitt, but my experience does not show that this is necessary. The other remedy is sufficient and is more easily applied. Oil grooves in the babbitt are, in my estimation, worse than useless.

T. TWISTER.

Milwaukee, Wis.

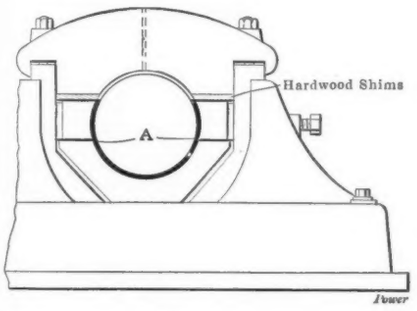
Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues.

Babbitting a Main Bearing

Mr. Belling, in the March 22 issue, quotes from Mr. Johnson's article, "How to Babbitt a Main Bearing," as follows: "In the ordinary four-part bearing, consisting of bottom, top and two side shells, only the bottom and side pieces should be babbitted as the top does not, should not and cannot touch the shaft while the engine is in operation. All time, effort and metal used on it are time, effort and metal wasted." Mr. Belling expresses disbelief that this has ever been practised.

Some engine builders babbitt the upper quarter box, more for the sake of formality perhaps than for any other reason, as it has been my observation that the majority of engineers seldom allow



BEARING WITH WOOD SHIMS UNDER CAP

the cap to touch the shaft. On the other hand, many builders send their engines out from the shops without any metal in the upper quarter box.

The running of main journals without babbitt in the upper quarter is not only common but good practice. In all properly designed main-journal boxes the three pieces constituting the sides and bottom afford sufficient bearing for the shaft. The cap should be drawn down tightly upon the two side pieces to hold them perfectly rigid. However, there are main bearings where the above rule will not apply. For instance, where the engine runs under, where the flywheel sits far away from the main journal or when the belt trains upward from the wheel. Any one of these causes or a combination of them may cause the shaft to "ride" on the side quarter box and rise out of the bottom box only to fall back again with a dull thud at the end of the stroke.

Engineers who have a baffling jar or thud in their main journals will do well to find out if any of the above conditions prevail. In such cases I have lowered the upper quarter box on to the shaft and cured the trouble.

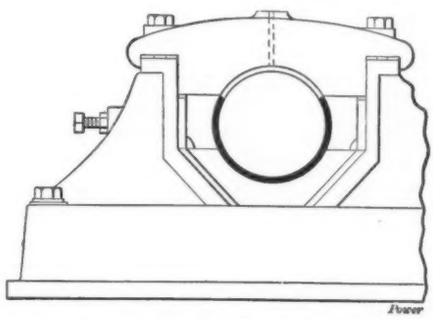
At present, I am running the upper quarter box of both the main and the outboard bearing, without babbitt. The cap is bolted down tightly onto wooden shims on the side boxes. The builders in this case had babbitted the boxes. Should any heating occur, this plan permits of quick distribution of large quantities of oil or water on the exposed shaft. On my engines there is nearly 5/16 inch clearance above the shafts.

My idea of a properly constructed main bearing is shown in the figure herewith, where the side quarter boxes are babbitted in such a manner that more of their surface is above the center line of the shaft than below. The corners at *A* should be relieved a little. I once worked as erector for engine builders, very well known to POWER readers, who, either by accident or design, made their side quarter boxes in a certain sized engine in the manner shown. This sized engine invariably ran smoother than other sizes where the quarter boxes were babbitted below or on the center line of shaft.

F. C. HOLLINGS.

Yazoo City, Miss.

In the issue of March 22, George C. Belling comments on F. L. Johnson's article, "How to Babbitt a Main Bearing." He fails to understand what is meant by, "In the ordinary four-part bearing, consisting of bottom, top and two side shells, only the bottom and side pieces should be babbitted. As the top does not, should not, and cannot touch the shaft while the engine is in operation, all



BEARING WITHOUT BABBITT IN TOP BOX

time, effort and metal used on it are time, effort and metal wasted."

Mr. Belling says that he cannot believe that this has ever been practised. I know that it is practised now by one large concern which builds Corliss engines, and there are, no doubt, others as well. In the engine I have in mind, the top cap comes down upon the quarter boxes, holding them firmly. No liners are necessary. As the babbitt in the bottom box wears, the quarter boxes are brought a little closer together. The figure herewith shows how they are arranged.

In engines having the top box babbitted there are liners between the top and the quarter boxes of sufficient thickness to provide clearance on top of the shaft. Should the top box be tight on the shaft, the chances are very good for a tight bearing. Now if the top box does not touch the shaft, why have a top box? In the sketch here shown, the cap holds the quarter boxes firm, much firmer than if liners were used, for it is iron to iron and there is no "give."

T. JONES.

Burlington, Ia.

Figuring the Economy of Economizers

In the issue of March 29, F. S. Hadfield confirms, as far as they relate to greatly overloaded boilers, my statements in the issue of February 1 to the effect that preheating the boiler-feed water in an economizer increases the actual heat-absorbing efficiency of the boiler itself, but questions their accuracy in regard to boilers driven at their nominal ratings. A comparison of the nominal ratings and boiler horsepowers developed in the three tests quoted in my article may, therefore, be of interest.

The boilers at the Natick mills were rated by the builders at 315 horsepower, based on 11 square feet per horsepower. The boiler horsepower actually developed in the test with the Green economizer was 252, considerably less than the builders' rating and still farther below the ordinary rating based on 10 square feet per horsepower.

The boilers at the Toronto Railway Company's plant contained 9000 square feet, which on the ordinary allotment of 10 square feet per horsepower would give a nominal capacity of 900 horsepower. The boiler horsepower actually developed with the economizer in use was 1347.8.

The battery of boilers tested at the Armour Packing Company's plant contained 9543 square feet of heating surface and the horsepower developed in the test with the economizer was 1167.

As far as these tests go, two are in favor of Mr. Hadfield's contention and one against. However, an examination

and comparison of a large number of boiler tests will, we believe, convince Mr. Hadfield that the ordinary nominal rating of a boiler at one horsepower for each 10 square feet of surface is above rather than at the point of maximum efficiency. If the heat transmission in boilers were strictly proportional to the velocity of the gases, boilers would have an equal efficiency at all rates of driving, neglecting radiation and similar losses and other variables. As it is, the percentage of heat rejected with the flue gases probably increases slowly but steadily with increased flow, due to increased rate of driving, that is, the chimney gases leave the boiler at a higher temperature as the rate of driving is increased.

On the other hand, the amount of heat lost by radiation is constant throughout, so that the percentage, as compared with the boiler output, decreases steadily with increased rates of driving. With a very light load, most of the heat is lost through radiation, and the boiler efficiency rises as the load is increased until the percentage lost in the gases exceeds the percentage lost in radiation. Neglecting other losses, this will be the point of maximum efficiency and the practical question is, just where does it occur?

In his book on "Steam Boiler Economy," William Kent has plotted the results of a large number of boiler tests and the results taken as a whole seem to show that the maximum efficiency of commercial boilers under ordinary conditions of testing is found at a rating corresponding to an evaporation of, roughly, two to three pounds of water per square foot of heating surface, per hour. Three pounds of water per square foot corresponds to the ordinary nominal rating of 10 square feet per horsepower, while two pounds would call for 15 square feet, more than is ever offered for sale as a "boiler horsepower" at the present time. Similar results were shown in a paper by R. S. Hale on the "Efficiency of Boiler Surface," presented before the American Society of Mechanical Engineers.

Doctor Kent's remarks summarizing these results are also of interest:

"The effect of the rate of driving indicates that for practically all values of the other variables the evaporation and the efficiency are maximum when the rate of driving is about two pounds evaporation per square foot of heating surface per hour, but that under fairly good conditions the efficiency is but slightly less at three pounds. When good operating conditions are obtainable the small saving in fuel by the larger boiler will probably be more than offset by its greater cost, so that practically boilers proportioned for a rate of driving of three pounds per square foot of heating surface per hour will give about the maximum economy of all costs, including interest on investment, depreciation, etc. When fuel is of very low cost, as near a coal mine, or when a boiler is to be run at full capacity only a few hours per day, as in electric-lighting plants, boilers proportioned for a much higher rate of driving may be the most economical in total cost."

GEORGE H. GIBSON.

New York City.

Connecting Rod Crosshead Joint

In the March 15 issue, Mr. Stewart, under the above heading, said that he preferred the taper-and-keys arrangement to the screwed end. The

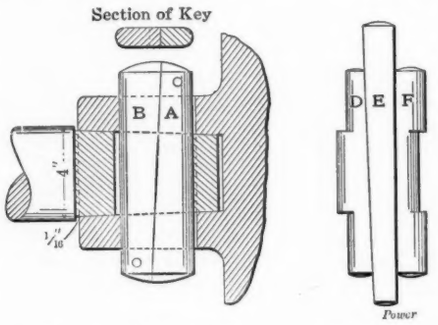


FIG. 1. DOUBLE KEY. DRAW KEY

taper-and-keys joint, if made correctly and of good design, is all right. Instead of a single two-taper key, I prefer the double key shown in Fig. 1. I think the taper on the rod should be at least one and one-half diameters long. This is an old but good design, the keys being easy to fit and adjustable.

I prefer to make a single, wide key, and when finished all over, set it up in the shaper and with a thin parting tool separate the key into two parts; this will insure the taper being the same on each key, and leave the sides parallel.

These keys are far easier to fit than a double-taper key of rectangular section. By inserting the key *A*, Fig. 1, to about its correct position, *B* may be lightly driven, to ascertain if the ends of the keys will be flush when the keys are driven home.

Should *A* have a tendency to follow *B*, when the latter is being driven, a small hard-wood wedge inserted between the split pin and the crosshead will hold it firmly in position. If *B* drives too far, it is a very easy matter to put a liner between *A* and *B*, thus increasing the width of the keys, without altering their fit.

To withdraw the keys, drive *A* until both are loose, when they can easily be removed, this being a great advantage over the single, double-taper key which has to be backed out from the side opposite to that from which it was driven. Often, this has to be accomplished, on many Corliss engines, through a hole in the bed of the engine, opposite the crosshead.

To draw the rod from the crosshead, I use a set of draw keys such as those shown in Fig. 1. These keys will easily draw a 4-inch piston rod with the use of a heavy hammer. It is necessary that the draw keys be well oiled with a good heavy oil before being driven.

With a screwed piston rod, I believe it to be good practice to use a split crosshead as shown in Fig. 2. The crosshead should be cast without the split which should be machined in after the crosshead has been rough bored. Then the holes for the locking bolts should be drilled and the bolts put in place, and pulled up after a liner, the thickness of the slot, has been inserted. These liners will keep the boring and threading tools from jumping, while threading and making the finishing cuts. This method allows the rod to be made to fit well in the thread. A couple of stake wedges driven into the slots will ease the fit when screwing the rod into place. After the rod has been screwed into exact position, the wedges can be backed out, the bolts heated until water will boil upon them and then quickly put into place and set up. Their shrinkage in cooling will insure a good solid job of the screwed end, one that will have no "shake" whatever.

The rod will always come adrift easily by removing the locking bolts and driving stake wedges into the slots. The advantage of this form of screwed rod over the jamb-nut type is that it can be made to fit better in the crosshead and still be easily screwed into place. With a 4- or 5-inch rod fitted with a jamb nut, the threads would have to be left pretty slack in order to screw the rod home and the jambing of the nut more than likely leaves the whole strain in two or three of the threads, and not distributed evenly amongst all of them. In many rods of this latter type that I have inspected, after they had broken, the break occurred at the root of the first or second thread, showing that the rod had a tendency to bend at this particular spot, due to poorly fitting threads and undue pressure put upon them at this point by the jamb nut.

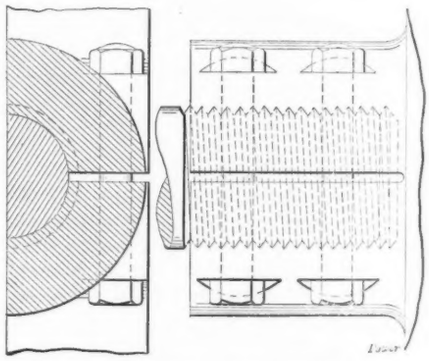


FIG. 2. THREADED CROSSHEAD WITH LOCKING BOLTS

In Fig. 3 is shown a typical marine crosshead of the vertical, single-slipper variety which is extensively used in the United States navy for all work of large size. This shows the taper-and-nut connection, a very old one and one that can readily be disconnected, when necessary, especially if the rod is of large diameter, say, 7 or 8 inches.

From a casual glance, bearing in mind how a taper of this description will stick

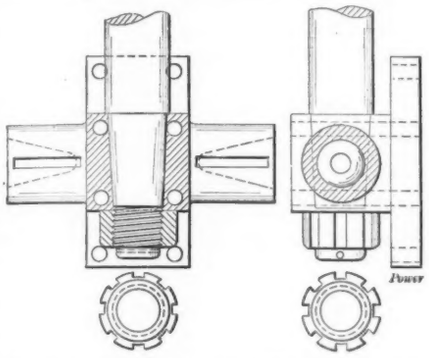


FIG. 3. SINGLE-SLIPPER MARINE-ENGINE CROSSHEAD

at times, and especially after being drawn into place by means of a tongue wrench and a 16-pound sledge, it would seem that to get one of these adrift would require long and careful treatment. While this is true, insofar as the power needed to remove it is concerned, yet, by a judicious use of power, these rods may be removed quickly as follows:

Remove the wristpin brasses. Then swing out the forked end of the connecting rod and remove the nut from the piston rod, connect up the wristpin brasses again and with the crank on bottom center, insert a steel block that is a good fit between the lower end of the piston rod and the forked end of the connecting rod. Now, start the jacking engine, to supply the power required to loosen the rod. Before the jacking engine sticks, the rod will come free.

E. A. BLACKWELL.

Kingston, N. Y.

Boiler Room Ventilation and Heating Question

In the issue of March 15 Mr. Manley presented a little problem in school-house heating, on which he desired to have other POWER readers comment. He states that he can heat his building quicker by using outside air instead of inside air for draft in the boiler room.

In my school I have two boilers and on a very cold morning I use two tons of coal from 5 to 8 a.m. Theoretically it takes about 156 cubic feet of air for the complete combustion of one pound of coal, but practically about 50 per cent. more is required, or 234 cubic feet. So in three hours there passes through my boiler room to the fires 936,000 cubic feet of air for the two tons of coal burned.

Mr. Manley very likely uses "inside air" to heat the building before the children arrive and ventilation is needed, and he can readily see that such a great amount of air, about 5200 cubic feet per minute, short-circuited into the boiler room instead of going through the heating coils and up through the building and down again, would make quite a difference in the time it takes to raise the temperature of my rooms to 70 degrees.

Mr. Manley may use more coal than I do and therefore require more air for his furnaces, but at any rate this letter may make him understand what might have changed the conditions in his school.

F. L. WAGNER.

Chicago, Ill.

Live Steam vs. Exhaust Steam for Heating

I have just read William Kent's discussion of the above, which appeared in POWER for April 5, and do not see why any approximations should be made. It would be much more simple to work the problem out by straight computation, instead of making assumptions.

For comparison, I shall take the same constants, which he used in his article, namely: Live steam at 20 pounds gage pressure expanded through a reducing valve to atmospheric pressure, exhaust steam at atmospheric pressure, room temperature 65 degrees Fahrenheit, and heat lost by radiation per square foot per degree difference between the temperatures of the steam and the room, 0.854 B.t.u. for superheated steam and 1.63 B.t.u. for exhaust steam.

The heat liberated per pound to superheat the expanded steam equals

$$1161 - 1146.6 = 14.4 \text{ } B.t.u.$$

Taking 0.48 as the specific heat of superheated steam, the degree of superheat of the expanded steam will be

$$14.4 \div 0.48 = 30 \text{ } degrees,$$

giving a temperature of 242 degrees Fahrenheit, or a mean temperature of the superheated steam of 227 degrees Fahrenheit.

The mean temperature difference between the superheated steam and room equals

$$227 - 65 = 162 \text{ } degrees.$$

The surface required to radiate the superheat of one pound of steam per hour equals

$$14.4 \div (0.854 \times 162) = 0.1042 \text{ } square \text{ } feet.$$

The latent heat of steam at atmospheric pressure is 965.7 B.t.u.

Temperature difference between the saturated steam at atmospheric pressure and the air of the room equals

$$212 - 65 = 147 \text{ } degrees.$$

The surface required to radiate the latent heat contained in one pound of saturated steam at atmospheric pressure per hour equals

$$965.7 \div (147 \times 1.63) = 4.03 \text{ } square \text{ } feet.$$

The total surface required to radiate the latent heat and superheat contained in one pound of steam at atmospheric pressure and at 30 degrees superheat per hour equals

$$4.03 + 0.1042 = 4.1342 \text{ } square \text{ } feet.$$

The superheated steam required to furnish heat for 100 square feet of radiating surface per hour equals

$$100 \div 4.1342 = 24.19 \text{ } pounds.$$

The total heat radiated from 100 square feet of heating surface per hour using superheated steam equals

$$24.19 \times 980.1 = 23{,}709 \text{ } B.t.u.$$

The total heat radiated from 100 square feet of surface per hour using exhaust steam equals

$$100 \times 1.63 \times 147 = 23{,}961 \text{ } B.t.u.$$

The difference in heat radiated from 100 square feet of surface, using superheated and exhaust steam, per hour equals

$$23{,}961 - 23{,}709 = 252 \text{ } B.t.u.$$

or 1.06 per cent. in favor of exhaust steam.

The area required to radiate the superheat contained in 24.19 pounds of steam equals

$$24.19 \times 0.1042 = 2.52 \text{ } square \text{ } feet$$

or 2.52 per cent. of the total surface.

If

p = Absolute pressure in pounds per square foot,

V = Volume in cubic feet,

T = Absolute temperature on the Fahrenheit scale, then

$$V = \frac{93.5\,T - 971\,p^{\frac{1}{4}}}{p}$$

By substituting the constants for the superheated steam in the above formulas, the volume per pound is found to be 27.36 cubic feet; and the volume of one pound of exhaust steam is given in the steam tables as 26.36 cubic feet.

The available heat per cubic foot of superheated steam equals

$$980.1 \div 27.36 = 35.82 \text{ } B.t.u.$$

The available heat per cubic foot of exhaust steam equals

$$965.7 \div 26.36 = 36.63 \text{ } B.t.u.$$

The difference in heat per cubic foot of superheated and exhaust steam equals

$$36.63 - 35.82 = 0.81 \text{ } B.t.u.$$

or 2.26 per cent. in favor of exhaust steam.

It will be seen from the above that there is very little difference between superheated and exhaust steam for heating purposes, the difference being slightly in favor of exhaust steam.

The writer has heard operating engi-

neers make the statement that it requires less coal to heat a building with exhaust steam than it does with live steam. When we remember that about 10 per cent. of the steam is condensed, when doing work in a cylinder, and is withdrawn by means of a steam separator, it would be of great interest to many of us to know what becomes of the excess heat contained in the live steam over that contained in the exhaust steam. We all know that 100 pounds of steam contains more heat units than 90 pounds, and it is somewhat of a puzzle to be told that the smaller amount of steam does the greater amount of work. Are the ones making such statements in earnest or merely joking? If I were in charge of a plant giving such results, I would not give the credit to the exhaust steam, but to some other function of the plant, unless more substantial proofs were given than have appeared in print thus far.

C. E. BURGOON.

Chicago, Ill.

The letter in the issue of April 5, on "Live Steam vs. Exhaust Steam for Heating," by William Kent, illustrates how far a discussion of this kind may ramble. The letter which Mr. Kent criticizes was intended to demonstrate that heat might under certain conditions be transmitted faster through a radiating surface from saturated or exhaust steam than from superheated steam. It was not claimed that a radiator fed with superheated steam would be filled with superheated steam all through, which Mr. Kent seems to infer, or that a radiator fed with saturated steam would transmit 54 per cent. more heat than a radiator fed with steam initially superheated. After the steam has been cooled to the saturation point, and is no longer superheated, it is quite true, as Mr. Kent points out, that the coefficient of transmission from saturated steam should be used in calculating the transmission.

The real issue was to prove that exhaust steam would transmit more heat through a square foot of radiator surface than would steam superheated by wire drawing through a reducing valve, from a comparatively low pressure, and the object of proving this point was, in turn, to meet certain criticisms made in the February 1 issue of an advertisement in which the statement was made that "Exhaust Steam Is Better than Live Steam for Heating Purposes," incidentally, because the transmission may be greater, but mainly and most emphatically because the combined cost of power and heat where exhaust steam is used for heating is generally less than the cost of producing steam for power and using live steam for heating independently.

Any little difference that there may be in the rates of transmission of heat between superheated and saturated steam is, in comparison with the economic considerations, merely chaff, and the kernel, namely, the fact that it is folly to burn coal for heating purposes and at the same time buy current for light and power, when the same coal could fulfil both requirements, seems to have dropped out of sight in the discussion.

GEORGE H. GIBSON.

New York City.

Popular and Technical Use of Terms

The editorial in a recent issue of POWER on the "Popular and Technical Use of Terms" bears on a subject which is of supreme importance. There is undoubtedly a great disparity in the meanings of words and terms used by the technical man and the layman. This difference, as you suggest so truly, is of considerable moment, and might, in cases of litigation, prove to be a fruitful source of dissatisfaction to any parties unfortunately concerned. Serious as such a state of things is, it is not nearly so serious, important or extraordinary as the undoubted fact that technical men themselves have different ideas as to the correct meanings attached to various terms in common use. I have noticed that even the technical journals many times are at fault. For instance, when reporting speed trials of ships, the term "knots per hour" as signifying sea miles per hour is often used. The correct interpretation of the word "knot" is a sea mile an hour; therefore the expression "a knot an hour" is absurd, for it implies an acceleration of a sea mile per hour per hour.

Such an error one naturally would expect in an unenlightened news sheet, but not in a technical journal in either America or England, where, however, it does occur frequently.

A truer example of my contention is found in the word "elastic." The statement, which to me sounds somewhat extraordinary, is made in the article above mentioned, that the common and accepted use of that word makes a body elastic which yields easily to an impressed force which tends to change its shape. With this I do not agree at all, nor do I think any layman will. Such a property as just described, is known almost universally as "ductility" and has nothing to do with elasticity. The interpretation usually placed upon the word elasticity is that the strain in a body will entirely disappear on the removal of the stress which produces it. This is the definition of an eminent engineer and I find that it agrees with the definitions given in two or three dictionaries in current use, in one of which elasticity is described as, "the power of returning to the form from which it is bent, extended, distorted or depressed;" nothing is said about the ease or difficulty in distorting the body, and I feel that the author of the article under discussion has gone a little wide of the mark in selecting this word as one of a contentious nature between layman and engineer. The true meaning of the word is as above described, and generally engineers consider and maintain that a body which can be greatly distorted and yet recover its original shape is greatly elastic whatever the force which causes that distortion may be. Glass is only elastic because it has this property up to its breaking point, very nearly; it has a high elastic limit expressed in terms of the breaking stress, but thinkers surely would not say that rubber has a lower elasticity. Rubber is really far more elastic than glass although its relative elastic limit may be lower. Your article, therefore, places technical men under the stigma of confusing a high modulus of elasticity with high elasticity, a thing which I cannot believe they do.

A good example of disagreement among scientists is found in the use of the words stress and strain. These, because of their haphazard use, are of sore trouble to the student. They are often used interchangeably to express the same thing, whereas each has a distinct meaning.

C. MANNOCK.

Sheffield, Eng.

Top Feed in Boilers

I was looking over POWER the other day, and I saw Mr. Terman's article on feeding boilers, in the issue for March 15. In Fig. 15 he shows a spray feed right over the fire grates, in the furnace. I don't see what good a feed like that can be, and I don't believe any boiler was ever designed with any such Jay rigging to it. The rest of the article is good.

JAMES WATT.

Singsing, N. Y.

Pound in an Engine

In a letter from Leroy Scott, in a recent issue of POWER, I notice that the cause of the pound in the engine he referred to some time ago is still unfound. I have a suggestion to make which may help to locate it if the engineer is willing to try it.

Mr. Scott, in his former letter, stated that the engineer claimed that the pound was caused by the engine running under. If Mr. Scott will get the engineer to experiment some day when the plant is idle, and reverse the eccentric so that the engine will run over, run the engine for a little while and then stop it in the usual way, it will prove to some extent whether the theory is correct or not.

I would be glad to have Mr. Scott report the result of the experiment.

A. A. BLANCHARD.

Oak Harbor, O.

Erosion of Brass Pipe by the Gases

Referring to Mr. Geicrin's trouble with a brass feed pipe in a smoke flue as stated in the March 8 issue, it is unlikely that the eating away of the pipe is due to electrolysis, for, since iron pipe is affected to a greater extent than brass pipe by electrolysis, the original iron feed pipe would have given the same difficulty that the brass pipe does now. This does not seem to have been the case.

It is well known that smoke which does not contain much soot, such as that from anthracite coal, will very rapidly corrode brass pipe. This must be the cause of the eating away of the feed pipe running through the smoke flue.

JOHN FRENCH.

Washington, D. C.

I do not think that either smoke or electricity had any great effect on Mr. Geicrin's feed pipe. In his case, the feed pipe is subjected to a mild form of sand blast. The wearing away of the pipe is probably caused by the small cinders carried along by the forced draft.

I have observed the same effect on copper exhaust nozzles in the smoke-stack of a tugboat.

JAMES H. CAMPBELL.

Detroit, Mich.

Engineers' Wages

In the March 15 issue, Mr. Morgan criticizes my previous contribution on the above topic.

I can write only about conditions in Massachusetts. They may be all right in Chicago but here there is much room for improvement.

My feelings, when I read an article on the subject, are that the men themselves are as much to blame as anybody. If they would get together and help one another, we might accomplish something. We cannot ever do this as long as the associations and unions show a partiality to a favored few.

Mr. Morgan says that a comparison is always made to brick masons and hod carriers. The reason for this is that the brick masons, in this State, are about the best paid laborers. The street laborer with his pick and shovel is better paid than the majority of second-class engineers. These men are classed as unskilled labor while the engineer is a mechanic; in other words, we are comparing unskilled labor with skilled labor. The unskilled man is getting the most pay.

Mr. Morgan states that engineers have steady work. The same thing has been said in these columns before. So does a horse have steady work, but nobody ever heard of this being given as a reason for feeding one less.

As to an engineer taking his troubles home with him at night, suppose that you had spent the best part of the day trying to figure out some difficult problem in hydraulics or steam piping, or in any of the many other things which an engineer has to deal with, would music have any charms?

There are more rungs in the ladder to climb but it takes study to move up and study necessitates books and books cost money, and, if we get a few cents more per hour, we may be able to get a few more books.

L. W. CHADWICK.

Bridgewater, Mass.

In reply to Mr. Morgan's article under the above heading, I would like to state that I certainly do believe in one statement which he makes; i.e. "It is always up to a man to sell his labor at the highest price obtainable." I would like to lay a little stress upon this point and state that I believe it to be not only his right, but his duty, duty to himself and those dependent upon him, to get all he can. It is only a business proposition in this respect, the same as it would be with a man in business getting all that conditions permit.

I do not believe there is any question but that the engineer is underpaid in comparison with a majority of the other trades.

I believe that most men are human and engineers should consider this when making demands for an increase in wages; we should talk to our employers in a friendly, business-like manner, and always talk and act as we would have others do if we were in a like position.

Mr. Morgan speaks of engineers sleeping on duty. In reply to this, I must say that such practice is to be condemned and should not be regularly indulged in by engineers; the time can be devoted to much better ends.

Also, he speaks about visiting, etc., on the employer's time. This practice, if regularly pursued, most generally results in getting the engineer into disfavor with the boss.

If a man is going to make stationary engineering his profession, let him put his all into it, and get all he possibly can out of it. If a man is working for $75 per month, for instance, and is confident that he is worth $90, then it is his duty to himself and to his profession to get the $90, or as much as he can and never stop trying until he succeeds. There is one thing which he can bank upon—if the boss continually finds him sitting down reading daily papers or absent from the plant, he is not going to succeed in getting the $90 per month.

I know of one case in which an engineer worked for eleven years as chief engineer for $75 per month, never even trying to increase his wages, and then quit because he had insufficient help and because the management would not install additional equipment. Another man took the place at $70 and held it for three years, never trying to get an increase (because he knew he was not worth it). This same position is now paying $90 for less work and shorter hours, due to the fact that the present incumbent not only made good, but so impressed it upon the employer's mind that the increase was readily granted. Needless to say, the increase was not all secured at one jump.

Mr. Morgan also speaks of there being few complaining letters in POWER as a proof that engineers are not an underpaid or dissatisfied class of men. Engineers are a patient class of men and when dissatisfaction does make its appearance, as it has since the first of the year, I must say that there is certainly something wrong, and that they are only falling into line with popular sentiment.

Just the other day, in one of the magazines I noticed a statement to the effect that Bradstreet's Commercial Agency reported that during the past 20 years the average increase in wages in the United States had been 24 per cent., while the cost of living during the same period had increased 66 per cent.

I suggest, now that the ball has been started, that the engineer readers of POWER, furnish POWER with information concerning the weekly or monthly wages received, the number of hours they are required to work, the nature of the work and whether they get paid for extra time. Let POWER print this data so that the engineers may know the true conditions existing elsewhere.

I do not think any engineer should hesitate for a moment to tell the absolute truth in such a cause as this.

WALDO WEAVER.

Middletown, O.

Jammed Piston Ring

In the March 29 issue of POWER I noticed Mr. Prichard's letter entitled "Jammed Piston Ring." It would seem, from my experience and observation, that his method of getting out of this difficulty was a little severe, considering the small size of the engine cylinder, 12 inches. Of course, there may have been something interfering, out of the ordinary, which I cannot learn of from his description.

But it seems as though it should have been possible to have pushed a number of thin case knives between the ring and cylinder wall opposite to the port and gradually to have worked them around until the ring was lifted out of the port.

If this could not be done, probably he resorted to the only way of overcoming his trouble, but it must have been "tough" on the remaining parts of the engine as well as on the engineer.

LOYD V. BEETS.

Nashville, Tenn.

In the March 29 number, W. M. Prichard gives his experience with a jammed piston ring.

Having had a similar experience, I would like to let him know how I overcame the trouble. The engine was a 12x12-inch slide-valve affair with a solid piston 3 inches thick having two ¾-inch rings. The cylinder had been bored out until there was less than 1/32 inch counterbore. My helper started to put the piston in during my absence. He left the open side of the ring in line with the upper end of the port. The result was that as soon as the ring got to the port, it snapped into it and no amount of pushing or pulling could make it come out. Instead of using a sledge hammer and breaking the ring, I took a few pieces of old hacksaw blades, ground them down on the end and starting at the bottom worked the ring back into the piston block. It took about one hour to get the first wedge started and in one and one-half hours I had the piston on the floor again none the worse from its experience.

A. R. HILBERT.

Rutherford, N. J.

Since reading of Mr. Prichard's experience in the March 29 issue, I have been wondering if it would not have been possible to have drilled a small hole, ¼- or ⅜-inch pipe size, into the cylinder opposite the port in which the ring was jammed, inserted a small rod and pushed the ring clear.

GEORGE RUSSELL.

Spring City, Tenn.

Newton's Law Suspended

I was much interested in the description of the ball and blower which appeared in the February 22 issue and now that some of the answers have appeared, I can no longer keep still. Some of the explanations offered in the April 12 number are on the side of truth but others show entire ignorance of the true laws of mechanics and fluid motion involved. Mr. Haynes' statement that the air in the jet is below atmospheric pressure is untrue. Such a fall in pressure takes place only when a fluid is accelerated without a supply of additional energy as in a contracted tube. In this case the blower supplies kinetic energy and the air is delivered at the same pressure as that of the surrounding atmosphere. The explanation offered by Mr. French is so general and hazy that it might be construed as supporting any actual proof that the phenomenon would take place. Mr. Squire's equilibrium polygon in Fig. 2 is correct, but he leaves out a very important consideration in the cause of the reaction *R*.

None of the explanations in this issue consider the effect of the rotation of the ball. On releasing the ball in the inclined jet its first natural tendency will be to drop. Now the maximum velocity in a jet is at the center and as the ball descends the difference in velocity of the air causes it to rotate, the top following the jet. In this state the skin friction will have the following effect on the air in the immediate vicinity of the ball. The air will pass freely above the ball because of its rotation while below it will be retarded by the additional friction and impact with the surrounding atmosphere. Now since the energy of a gas is composed of two parts, velocity and pressure, the sum of which must be equal if no work is done, we see that the pressure must be considerably greater immediately below the ball than above. Now if the ball is comparatively small and the mouth of the blower large, as seems to be the case, it is probable that the air will converge and again form a continuous stream after passing the ball. The film of air passing above the ball has a higher velocity than that passing below, and follows the ball around to a certain extent because of adhesion, so that the new stream will have a new direction deflected considerably from the original direction of the jet. The result will be a dynamic force tending to lift the ball the same as though the stream had been guided around by a turbine vane. It is principally the angular impulse due to adhesion which causes a ball to act in this way in a stream of water. Inasmuch as all motion is relative, I offer the above explanation. For much the same reason, a pitcher can throw a ball in such a way as to make it curve.

AMOS F. MOYER.

Minneapolis, Minn.

[Unfortunately for the integrity of Mr. Moyer's explanation, the ball does not rotate at all.—EDITORS.]

Mechanical Genius

Fred Eckley makes a rather misleading statement in his letter, "Mechanical Genius" in the March 8 issue, when he says that a four-horsepower gasolene engine burns 14 gallons of "oil" a month.

There must be something wrong for if a gasolene engine were to be so flooded with oil, the result would be a heavy carbon deposit on the cylinder or fouled ignition points which would stop the engine.

He must have had an extra man standing by with a bucket, pouring oil onto the flywheel or other parts.

Now, as oil costs about $1 per gallon, that is, oil fit to be used in a gas engine, it must have been an expensive proposition to keep that engine running, to say nothing of the gasolene expense.

J. E. BATES.

Spokane, Wash.

[Mr. Bates is probably misled by Mr. Eckley's use of the word "oil." It is evident to us that Mr. Eckley meant "gasolene."—EDITORS.]

The Steam Turbine in Modern Practice

I was much interested in the article in the issue of March 8 on "The Steam Turbine in Modern Practice." Some of the statements in the article call for such drafts on my credulity that I venture to write for verifications.

Some explanation should be given as to how it was possible to accomplish the change made at the Fisk street station of the Chicago Edison Company where 5000-kilowatt turbines were replaced by 12,000-kilowatt machines occupying no more floor space and requiring no more boiler capacity and the similar evolution now under way at the station of the Union Electric Light and Power Company at St. Louis, where 12,000-kilowatt machines are to replace those of 5000 kilowatts capacity without requiring a change of base nor a breaking of the condenser joint. It is stated that the same steam pipes are to be used as were used by the smaller turbines. We are left to presume that no additional boiler capacity is needed to develop the 140 per cent. additional power for which the new turbines were designed and that the new turbines require no greater floor space than the old ones.

Another remarkable case of modern turbine practice, according to this article, is found in the plant of the Interborough Rapid Transit Company in New York City where low-pressure turbines are installed as auxiliaries, using the steam after its expansion in reciprocating engines, "operating under the best possible engine conditions and developing an economy comparable with the best engine stations in the country." The low-pressure turbines, driving generators in parallel with the generators driven by the reciprocating engines, are credited by the article with effecting a saving in coal consumption of 20 per cent. It is stated, further, that the combined power output is double that of the engines alone, the original economy of which, as quoted above, was equal to that of engine in any station in the country.

If these statements are cold facts it is time that many of the power users on the Pacific coast were made aware of the costly waste of energy going on in their engine plants and it seems to me that it is up to POWER to verify these statements and more fully specify the conditions which existed before the changes were made which made it possible that such an increase in capacity and saving in coal consumption could be shown.

W. A. CLARK.

San Diego, Cal.

An Advance in Turbine Design

In the course of the discussion of the Stott-Pigott paper, "Test of 15,000-kilowatt Engine-Turbine Unit," recently presented to the American Society of Mechanical Engineers, Dr. William Robinson called attention to some improvements in turbine design which he had perfected and secured patents upon.

One set of patents covers a design to secure a capacity for a given set of overall dimensions greater than is obtained by turbines of the usual builds.

One manner in which Doctor Robinson expects to accomplish this is shown in the sectional view in Fig. 1. On the fixed shaft *A* the sleeve *B* is arranged so that it may be rotated freely within the case *C*. Turbine blades or buckets are arranged on the outer case, the rotating sleeve and the fixed shaft in a series of stages in the manner shown. The main steam-supply pipe is at *D*. To start the turbine, valve *F* is opened and steam passes through the hollow end of the shaft *A* into the first bucket chamber between the shaft and the rotating sleeve from which it passes, to act upon the blades in each successive stage. Reaching the lower end of the turbine, the steam enters the core in the central shaft and passes through the return pipe *G* to the head end where it enters the space between the outer case and the revolving sleeve. In this outer chamber it does work upon the three remaining sets of blades and reaches the annular space *H*, from which it passes out through the exhaust pipe *E*.

In the event of the turbine becoming overloaded, by opening the valve *J* in the branch of the steam-supply pipe, high-pressure steam can be admitted directly to the outer sets of buckets, and in this manner the power of the turbine can be greatly increased.

The design shown in Fig. 2 utilizes the same general scheme for obtaining compactness as does the one just described, but is intended to give greater flexibility in overload-carrying power.

In this design the shaft *A*, Fig. 2, is fitted with the cylindrical valve *B* which contains numerous ports for feeding steam directly into the various stages of the inner chamber. The main steam supply is brought through the branch pipe *C* and the annular space *D* from which it is supplied to the valve *B* by the passages *E*. From the annular space *D* the passage *F* leads to a secondary valve *G* by means of which the admission of steam to pipe *H* is controlled. The valves *B* and *G* are operated by the lever *J* which is fulcrumed at the point *I*.

By shifting the operating lever to one notch to the right, the valve *B* is moved to the right so that the ports *K* are uncovered, and steam is admitted to the turbine blades in the first of the stages in the inner chamber. The same motion of the operating lever shifted the secondary valve *G* so that the port *L* is uncovered; thus steam is also admitted to the buckets of the first stage in the outer chamber, when the valve *Q* in the pipe *H* is open.

Shifting the operating lever to the second notch to the right, uncovers ports *M* and steam is admitted to the buckets of the second stage in the inner chamber.

The openings in the valves at ports *K* and *L* are large enough to leave those ports still uncovered, and the steam continues to flow to the buckets of the first stage.

By another shift of the lever *B* to the right, the ports *N* are opened and steam is admitted to the valves of the last stage in the inner chamber.

When the operating lever is shifted to one notch to the left of its neutral position, the ports *K*, *M* and *N* remain closed but ports *E* and *L*, are uncovered by the openings *O* and *P* and steam is thereby admitted only to the first stage in the outer chamber.

By closing the valve *Q* in the pipe *H*, the steam supply is cut off from the outer chamber.

By opening the valve *R* in the pipe *S*, branching from the main steam-supply pipe, steam may be admitted directly to the outer chamber without passing through the operating valve. This serves as an emergency bypass. In the event of the operating valves becoming stuck it would be possible to keep the turbine in service simply by using this bypass. The exhausts from both chambers pass out through the pipe *T*.

By arranging blades on the inside and outside of a revolving sleeve it is claimed that greater capacity can be secured without any increase in the size of a given turbine.

In one form of design, the arrangement of one set of blades is reversed. By admitting steam to the inside of the sleeve, the turbine is made to operate in one direction.

By changing the supply of steam to the outside of the sleeve, the direction of rotation is reversed. Thus, a reversible turbine is secured.

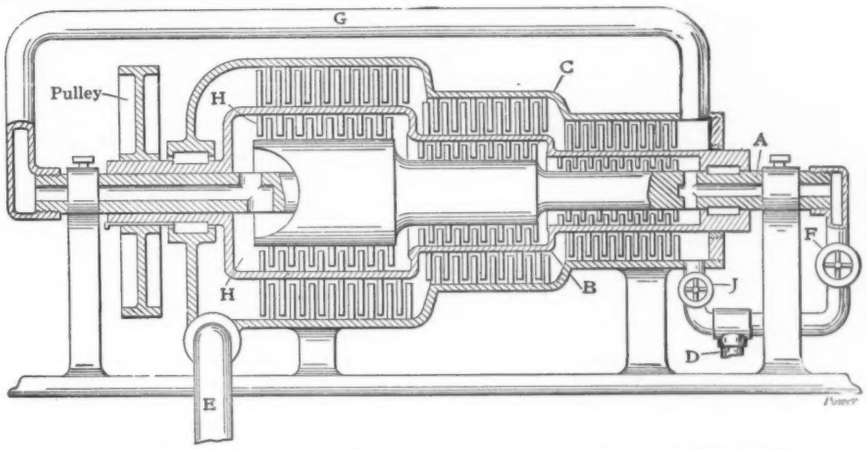


FIG. 1. DESIGN TO SECURE INCREASE IN CAPACITY WITHOUT REQUIRING INCREASE IN SPACE OCCUPIED

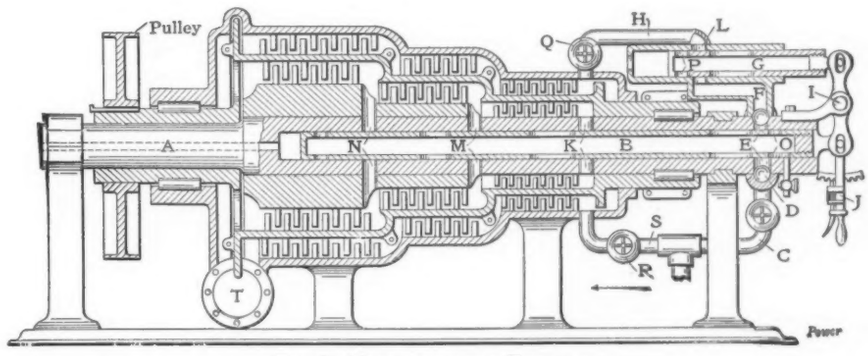


FIG. 2. VARIABLE-LOAD TURBINE

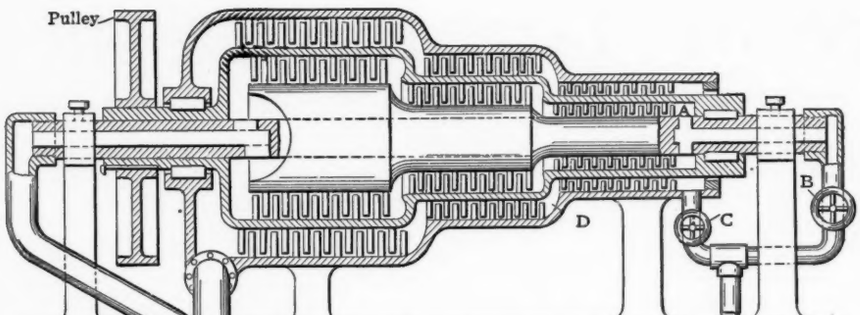


FIG. 3. REVERSIBLE TURBINE

By the arrangement of valves in this design, the steam supply and distribution can be regulated so as to accommodate variable loads with good economy.

In Fig. 3 is shown a turbine designed so that it may be reversed. By admitting steam to the inner chamber *A* through the valve *B*, the turbine is operated in one direction. By closing the valve *B* and opening valve *C* steam is cut off from chamber *A* and supplied instead to the outer chamber *D*.

The arrangement of the blades in the outer chamber is the reverse of that of the blades in the inner chamber, consequently by changing the steam supply, the turbine may be made to run in either one direction or the other.

The design in Fig. 4 is similar to that shown in Fig. 2. The chief differences are in the arrangement of the blades in the outer chamber and in the location of the port openings in the secondary valve *G*. The blades in the outer chamber are reversed so that by cutting off steam from the inner chamber and supplying it to the outer chamber the turbine is made to rotate in the opposite direction. By moving the valve-opening lever *J* to the right, steam is admitted successively to the different stages in the inner chamber but remains cut off from the outer chamber. Shifting the lever to the left of its neutral position lets the steam into the outer chamber, but cuts it off from the inner one and due to the arrangement of the blades, the turbine is made to operate in the reverse direction.

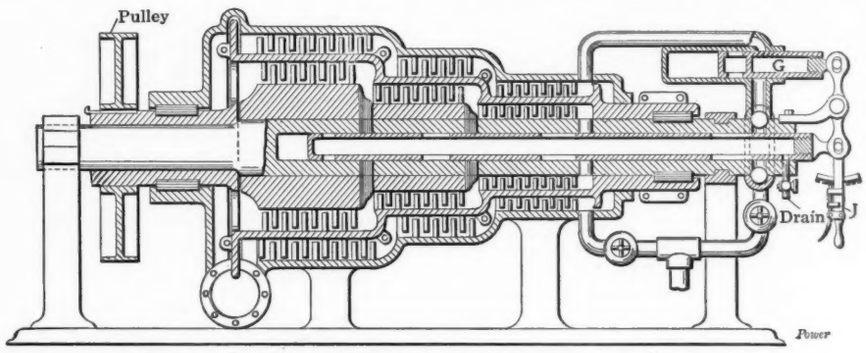
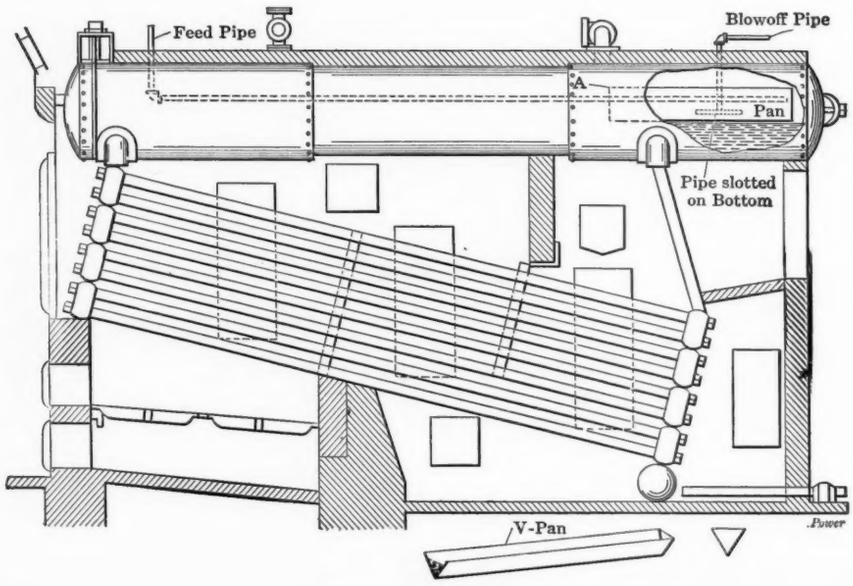


FIG. 4. REVERSIBLE TURBINE FOR VARIABLE LOADS

Settling Pan in Water Tube Boiler

The practice of discharging boiler-feed water into settling pans within the boilers themselves has brought out a good many methods, the idea being to catch the scale-forming elements before they mingle with the contents. Each type of boiler calls for a different design of pan, the idea in all being, however, to heat the feed water as hot as possible before it is discharged into the pan.

A case recently came to my notice which is a little different from most arrangements, in which the pan was used in a Caldwell water-tube boiler. In this type of boiler, the rear header connections join the steam drum some little distance from the rear end. This gives considerable room between the end of the drum and the opening to the headers, and in this space the pan is connected and suspended, as shown in the illustration. The pan is V-shaped as shown, the discharge end, which is placed facing the front end of the boiler, being made, as shown at *A*, 1½ inches lower than the other, which is the full hight of the pan.



SETTLING PAN IN DRUM

The feed-water pipe enters the steam drum at the front end, passing to the rear end at a hight just above the average water line. By this arrangement the feed water is discharged into the pan at a high temperature and the liberated particles of solid matter are deposited in the pan. The outlet end of the discharge pipe is fitted with an elbow, into which is screwed a piece of pipe with a tee, to which are fitted two slotted pipes, the slots being on the bottom. This cross pipe comes at the bottom of the V-shaped pan. The pan is suspended by means of four straps and is emptied of the deposits on regular cleaning-out days.

Comparative Trials of Scout Cruisers

The official results of the trials of the "Birmingham," "Salem" and "Chester," which are finally available, show that the "Birmingham," which is driven by reciprocating engines, has the best economy for speeds up to 20.6 knots. Above this speed the "Chester," in which are Parsons high- and low-pressure turbines, is the most economical. The "Salem," equipped with Curtis high-pressure turbines, showed the least economy up to 22.25 knots, but above this speed its steam consumption is lower than that of the "Birmingham."

Authentic information in regard to the comparative performances of the "Birmingham," "Salem" and "Chester" is at last available in a published report of their comparative trials, issued by the Bureau of Steam Engineering of the Navy Department.

The hulls of these boats, except in minor particulars, are alike and the full-load displacement of each is about 4710 tons. The "Birmingham" is equipped with two vertical, inverted, four-cylinder, direct-acting, triple-expansion, reciprocating engines designed for an indicated horsepower of 8000 at 200 revolutions per minute with a steam-chest pressure of 250 pounds gage.

The driving machinery of the "Chester" consists of Parsons marine steam turbines driving four independent shafts, each fitted with one propeller. There are six ahead and two backing turbines. The outboard shafts are driven by one high-pressure turbine each. One inboard shaft is turned by one high- and one low-pressure machine while the other inboard shaft is driven by one intermediate- and one low-pressure turbine. In the casings of the low-pressure units the reversing turbines are located. For speeds up to 18 knots, all six machines are operated, since with this combination less steam is required. For speeds between 18 and 23 knots, a five-turbine combination uses the lowest amount of steam; consequently, steam to the high-pressure turbine on one inboard shaft is cut off and this unit revolves idly in a vacuum. For the highest speed only four turbines are operated. In addition to the inboard high-pressure, the intermediate-pressure machine is cut out.

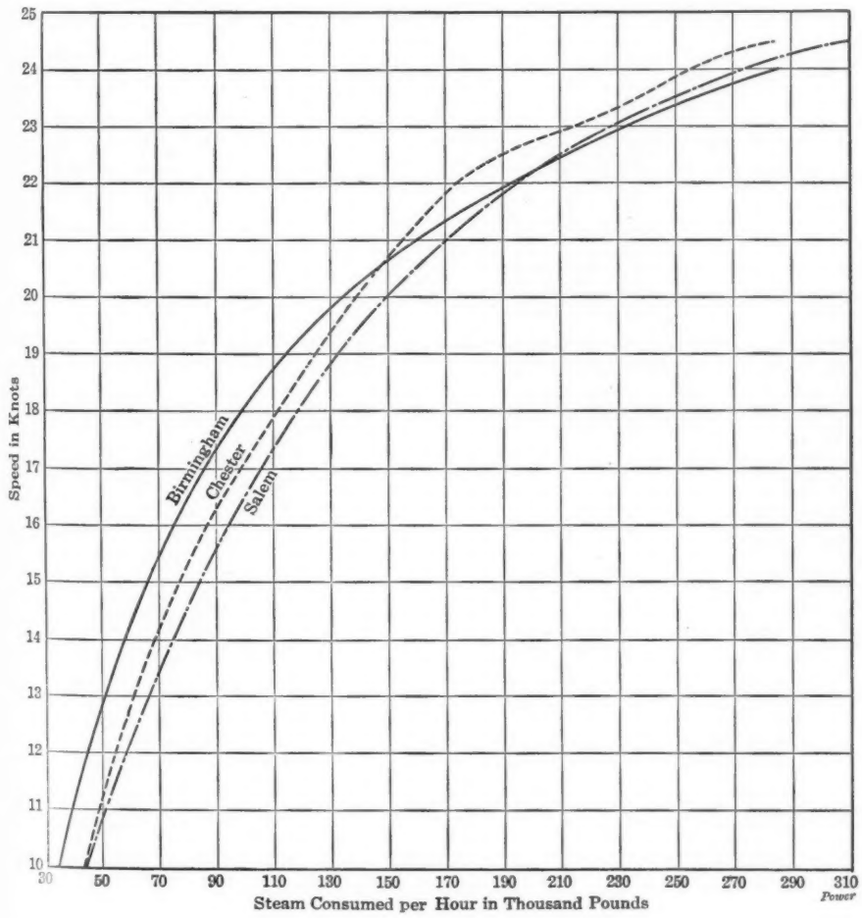


FIG. 1. TOTAL STEAM CONSUMPTION FOR ALL PURPOSES EXCLUSIVE OF LIFT PUMPS

The "Salem" is driven by two Curtis, marine, reversible, impulse turbines, designed to develop 8000 horsepower at 350 revolutions per minute with 250 pounds steam-chest pressure.

An examination of the curves in Fig. 1 shows that, based on total steam used for all purposes (excluding lift pumps), the "Birmingham" is the most economical of the scout vessels up to 20.6 knots, or when using one-half of the designed power of the engines. Above that speed the "Chester," using the five-turbine combination, becomes the most economical. Up to 22.25 knots the "Birmingham" is more economical than the "Salem," but above this speed the "Birmingham" becomes the least economical of the three vessels.

Based on the steam used at various speeds per hour by the main propelling machinery only (exclusive of all auxiliaries), the relative economies change but slightly. Up to 20.6 knots, Fig. 2, the "Birmingham" has the lowest water rate. Above this speed the "Chester" shows the best economy. At 22.55 knots the "Salem's" steam consumption is equal to that of the "Birmingham," while for the highest speeds it is slightly better.

Conclusions as to the relative steam consumption of the auxiliaries, for accuracy of comparison, should be based on close regulation of such machinery in accordance with actual requirements. The quantity of condenser cooling water required, to cite an example, is largely dependent upon sea temperature, and in consequence this becomes a controlling factor in the speed of the circulating pumps. Moreover, for each speed of the vessel, under conditions existing at the time, there is a point of regulation which gives minimum steam expenditure for each auxiliary. On the main steam-consumption tests close regulation of auxiliaries was not attempted, but on the coal-consumption tests every effort was made to reduce the steam thus expended to a minimum. Comparisons, therefore, are based upon the results of these trials, as shown in detail in Table 1.

The various auxiliary machinery installed on the three vessels may be classed arbitrarily under the following three heads:

1. Light auxiliaries, whose steam consumption depends largely upon efficient condition of working parts and speed of operation, and which class includes a large percentage of the auxiliaries of

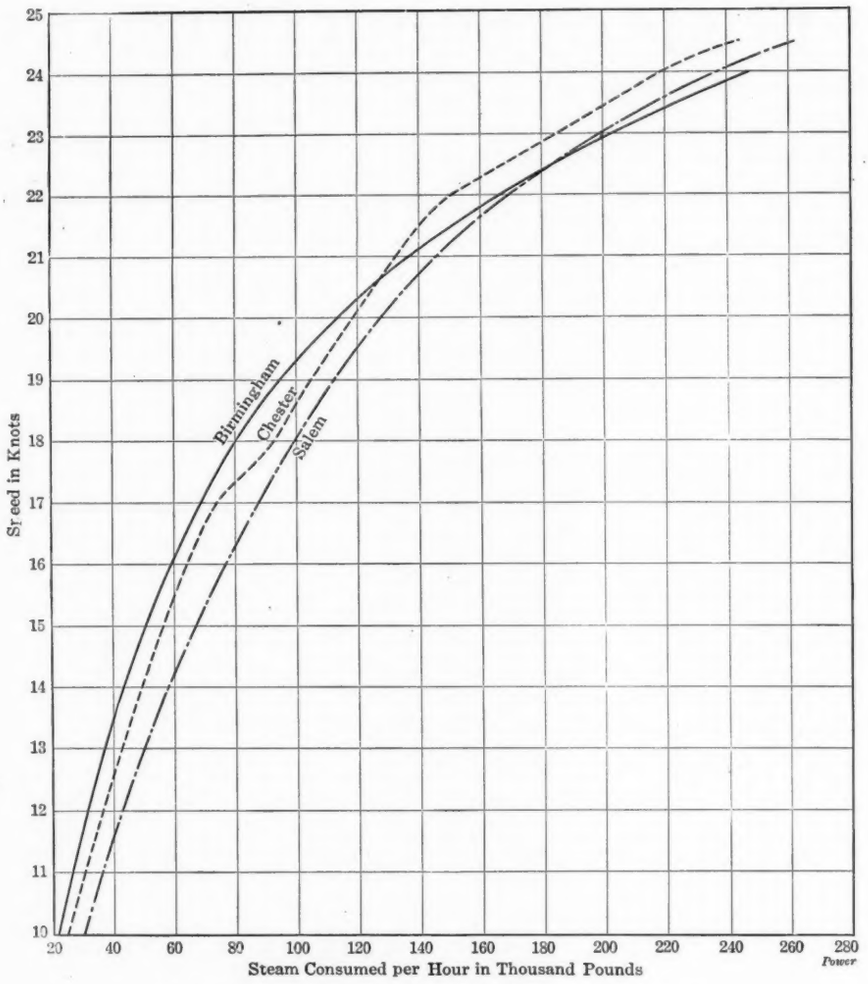


FIG. 2. STEAM CONSUMPTION OF MAIN ENGINES ONLY

the three ships. The steam expended for these auxiliaries should not be widely different under like conditions of use.

2. Main condenser auxiliaries, disregarding steam used by the main circulating pumps. It will be seen in Table 1 that the "Birmingham's" condenser equipment required the least steam expenditure during all of the trials, except at full power, when the "Salem" used 6 per cent. less. The greatest expenditure was on the "Chester," indicating that the "Salem's" wet- and dry-vacuum pumps are less expensive in steam used than the "Chester's" augmenters and air pumps. It should be pointed out, furthermore, that with the exception of circulating pumps, which are similar, the main condenser auxiliaries differ radically in type, which makes comparison of their steam expenditures desirable and important.

3. Forced-draft, blower installations. Based on the steam consumption per hour per indicated horsepower, the "Chester's" equipment shows a variable gain in economy as compared with the other two vessels of 6 per cent. at low powers (5 indicated horsepower) extending to 16 per cent. at high power (35 indicated horsepower).

Due to dissimilar propeller efficiencies, it is obvious that a comparison based on steam consumption of the machinery, either main or inclusive of all auxiliaries, per horsepower would not indicate the relative economies of the three vessels with the same degree of accuracy as the steam used per knot. As illustrating this, results of coal-consumption trials may be cited. For example, in trial 3, at a speed of about 20 knots, the average shaft horsepower of the main engines or turbines necessary to propel each of the three vessels, given in the following is: "Birmingham," 7120.5; "Salem," 6883.3; "Chester," with the five-turbine combination, 8374.

In order to effect a true comparison between the steam-generating appliances on the scout vessels, it is essential to take into consideration, not only boiler efficiencies, but, as well, expenditures of steam (forced-draft blowers) necessary in conjunction with the service operation of the plants. Differences in design have been pointed out, and it is to be noted that due to the tortuous passage of the gases of combustion across the tube-heating surfaces of the boilers of the

TABLE 1. STEAM CONSUMPTION OF AUXILIARIES IN POUNDS PER HOUR.

COMPILED FROM COAL CONSUMPTION TESTS.

Test No.	Main Air Pumps.		Wet Vacuum Pumps	Dry Vacuum Pumps	Augmenters.	Main circulating pumps.			Steam consumption of main condenser auxiliaries (exclusive of main circulating pumps).			Steam consumption of auxiliaries necessary to propulsion—includes main condenser auxiliaries; forced-draft blowers; oil pumps: Salem, Chester.			Steam consumption of auxiliaries not necessary to propulsion.			Total steam consumption of auxiliaries.		
	Birmingham.	Chester.	Salem.	Salem.a	Chester.	Birmingham.	Salem.	Chester.	(a) Birmingham.	(c + d) Salem.	(b + e) Chester.	Birmingham.	Salem.	Chester.	Birmingham.	Salem.	Chester.	(n + q) Birmingham.	(o + r) Salem.	(p + s) Chester.
	a	b	c	d	e	f	g	h	k	l	m	n	o	p	q	r	s	t	u	v
1	2,220	3,550	958	2,600	1,971	985	1,230	800	2,220	3,558	5,521	5,705	7,963	9,006	8,018	6,978	5,899	13,723	14,941	14,905
2	2,400	2,600	974	2,636	2,032	1,060	1,560	1,160	2,400	3,610	4,632	7,696	11,951	9,314	8,157	6,190	5,006	15,853	18,141	14,320
3	2,970	4,850	1,099	2,598	1,890	1,460	3,360	1,900	2,970	3,697	6,740	13,930	20,412	15,680	7,244	7,184	5,641	2,174	27,596	21,321
4	4,540	5,500	1,662	2,585	2,291	2,050	3,380	3,585	4,540	4,247	7,791	35,883	40,532	30,840	3,578	3,584	3,215	39,461	44,116	34,055
COMPARISON OF ABOVE BASED ON "BIRMINGHAM" (AUXILIARIES) AS 100.																				
1	100	160	43	132	100	100	125	81	100	160	249	100	140	158	100	87	74	100	109	109
2	100	108	41	130	100	100	147	109	100	150	193	100	155	121	100	76	61	100	114	90
3	100	163	37	137	100	100	230	130	100	124	227	100	147	113	100	99	78	100	130	101
4	100	121	37	113	100	100	165	175	100	94	172	100	113	86	100	100	90	100	112	86

aComparison of dry vacuum pumps with augmenters as 100.

TABLE 2. COAL-CONSUMPTION TESTS.

No. of Test.	Approximate Speed.	Duration of Test in Hours.	Birmingham.				Salem.				Chester.			
			Average Pressure in Fire Room in Inches of Water.											
			Number of Boilers in Use.	No. of Fire Room. 1	2	3	Number of Boilers in Use.	No. of Fire Room. 1	2	3	Number of Boilers in Use.	No. of Fire Room. 1	2	3
1	10	96	3	.....	.....	0.694	4	.....	0.325	.....	4	....	....	.....
2	15	50	8	.....	0.546	0.788	8	.....	0.407	0.418	7	....	....	.....
3	20	98	12	1.227	1.214	1.174	12	1.57	1.58	1.554	12	....	....	[a]0.9
4	(b)	c24	12	5.077	4.942	5.807	12	5.08	4.84	5.11	12	3.03	3.03	3.03

TOTAL EVAPORATION PER HOUR—BLOWER STEAM—NET AVAILABLE STEAM.

			Total Evaporation. A[d]	Blower Steam. B[e]	Net Available Steam. (A—B)[f]	Total Evaporation. C[d]	Blower Steam. D[e]	Net Available Steam. (C—D)[f]	Total Evaporation. E[d]	Blower Steam. F[e]	Net Available Steam. (E—F)[f]
1	10	96	32,871	990	31,881	44,674	873	43,801	36,097	.....	36,097
2	15	50	67,438	1,961	65,477	84,280	2.219	82,061	74,596	.....	74,596
3	20	98	129,176	5,200	123,976	163,111	7,385	155,726	134,270	525	133,745
4	(b)	24	271,545	18,493	253,052	293,103	24,820	268,283	314,161	6,516	307,651

PER CENT. OF TOTAL EVAPORATION PER HOUR—BLOWER STEAM—NET AVAILABLE STEAM.

1	10	96	100	3	97	100	2	98	100	0	100
2	15	50	100	3	97	100	3	97	100	0	100
3	20	98	100	4	96	100	4	96	100	0.4	99.6
4	(b)	c24	100	7	93	100	8	92	100	2	98

[a]Forced draft used intermittently 50 hours. [b]Maximum speed; Birmingham, 24 knots; Salem, 24.32 knots; Chester, 25.08 knots. [c]Birmingham discontinued this trial after 12 hours. [d]Total water evaporated per hour, in pounds. [e]Steam used per hour by forced-draft blowers, in pounds. [f]Net available steam per hour, in pounds.

"Birmingham" and "Salem," higher fire-room air pressures must be maintained, as compared with the "Chester's" boiler installation, to burn the same weight of coal. Under similar conditions as to air pressure, there is a wide difference in the amount of coal consumed. On the 10- and 15-knot coal-endurance runs, the "Chester" steamed under natural draft, while on the other two vessels, with a number of boilers in operation, forced draft was a necessity. It will be apparent, therefore, that a comparison of the steam-generating apparatus should be based upon the percentage of available output of steam, in addition to boiler efficiency, as recorded in Table 2.

All test data cannot be secured with the same degree of accuracy. In regard to the accuracy of the data on the quantity of condensed water collected it may be stated that as the time interval was always recorded, there is but little likelihood of a mistake having been made in recording the number of full tanks. Any error which might arise would, therefore, be confined to the reading of the hights of water in the tanks at the beginning and ending of a run. Probable error due to this source, when distributed over the whole trial, would not be of any importance.

Notes on Ammonia Compressors

By C. P. Wood

Besides enumerating the advantages of the various types of compressor, the author briefly considers important points of design, rating of compressor and regulation.

Compressors may be vertical or horizontal, single- or double-acting, simple or compound. They may be cooled by oil or by a water jacket, or by saturated NH_3 gas.

Advantages claimed for vertical machines are, among others, small friction loss and consequent decrease in wear of piston and cylinder, also less probability of leakage due to worn cylinder or piston. Another advantage is that the rod does not rest heavily on the packing in the stuffing box, making it easier to keep the packing perfectly tight.

For the horizontal type, it is claimed that it will pump equally well either dry or saturated gas, that it requires very little more floor space than a vertical machine and much less head room, that the moving parts being near the base makes it easier for the strains to be resisted by the foundations, that all the parts are easily accessible from the floor.

An advantage of single-acting machines is that by the use of a safety head and a valve in the piston they can be operated without any clearance between piston and head, thus preventing one of the usually serious losses. Another advantage is that by using only the head end of the cylinder for compression, there is no loss due to leakage around the rod through the stuffing box, the pressure there being no higher than suction.

The double-acting machines, giving compression at each end of the stroke, have obvious advantages in high efficiency of both the steam and ammonia sides of the system, when all parts are considered at the same time instead of separately. The clearance loss has been reduced to a minimum in the best designs.

In compound machines the compression is accomplished by stages in two or more cylinders; this has not proved to be of any practical advantage.

The loss due to clearance may be explained as follows: Suppose the high-pressure ammonia equals 180 pounds and the low-pressure 20 pounds; then the ratio is 1 to 9. Therefore, if the clearance equals 1/9 inch, the gas left in cylinder at the end of the compression stroke will take up 1 inch of space during suction stroke, keeping out that much fresh gas and reducing capacity accordingly.

This explains the desirability of having the piston travel the full length of the cylinder every stroke. The practical disadvantage of this is that when foul ammonia liquid or oil is drawn in in a very large quantity, or when a valve breaks and gets into the cylinder, the machine is liable to be wrecked.

In single-acting vertical machines, the head can be held on by springs, strong enough to withstand the working pressure, which will relieve the machine in a case like that described.

In the De la Vergne system, oil is injected into the cylinder after the beginning of compression; this fills the clearance space, insuring complete expulsion of the gas, and is released through a passage which opens at the end of the stroke. Another function of this oil, which is cooled in a special oil cooler, is to take up the heat generated during compression, there being no water jacket to the cylinder.

Siebert has patented a bypass which opens at the end of the stroke, allowing the compressed gas confined in clearance to escape from the compression to the suction side of the piston.

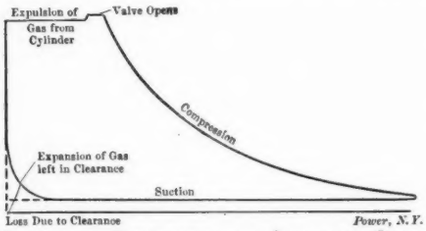
It can be seen from the foregoing that the working space allowed for suction

valves will have the same effect as clearance. When located in the heads, these valves are designed to fit flush, reducing loss as much as possible. The suction-valve area generally allows for a gas velocity of about 4000 to 4500 feet per minute. The "Triumph" design has strainers over inlet valves to keep foreign substances out of the cylinder.

The accompanying indicator diagram shows graphically the cycle of events in the compressor cylinder. The space between the curve and the dotted line in the lower left-hand corner represents the loss due to clearance. The line of gas expulsion is perfectly straight when the valve works perfectly. The distance between the atmospheric line and the suction line represents suction pressure. Close-grained hammered steel, with a tensile strength about 75 per cent. greater than cast iron, is generally used for the manufacture of compressor cylinders.

The stuffing box is an important part, especially in double-acting machines. It is often divided into several compartments, sometimes employing oil or water under pressure. The cylinder should have indicator connections and provision for thermometers at the inlet and discharge. There should be a bypass, connected in such a way as to make it possible to exhaust the condenser by pumping the entire charge into the refrigerator, or *vice versa*.

The capacity of compressors is rated in two ways: (a) Ice-making capacity (tons of ice made in twenty-four hours); (b) refrigerating capacity (cooling work compared with melting one ton of ice in twenty-four hours). Power for driving compressors is provided at the rate of from 1.5 to 3 horsepower per ton of refrigerating capacity, depending upon the size of the machine. Except in very small machines, common practice is to drive



INDICATOR DIAGRAM FROM AMMONIA COMPRESSOR

with the Corliss engine. A popular design is a vertical compressor driven by a horizontal Corliss, the engine connecting rod and compressor connecting rod being mounted on the same crank pin. This is a good, compact design, especially with a twin compressor and cross-compound engine. The objection is that the length of stroke of the engine is limited to that of the compressor when a longer engine stroke would be more economical. There is a successful tandem horizontal design, i.e., with the ammonia-compressor piston mounted on the extension of the steam piston rod.

Compressors must have very heavy flywheels to insure uniformity of motion. In the best designs for gas-engine drive, the engine is belted to a countershaft, which is belted to the compressor. In case of electric-motor drive, the power is best transmitted by gears or by a noiseless chain of the Morse type.

Many ingenious devices have been brought out in connection with small, self-regulating systems, some of them even portable. The compressor is sometimes connected with the driving pulley through a friction clutch, allowing the machine to speed up gradually. The clutch can be controlled by a governor to regulate the speed of the compressor. There are systems in which the pressure in the expansion coils acts on a diaphragm which regulates the feed of ammonia and the expansion valve; the temperature of the refrigerator, through a thermostat, regulates the motor speed; a pressure valve on the condenser regulates the condensing water, and an emergency valve on the condenser throws a switch to stop the motor when the condenser pressure becomes dangerously high.

Unit Coal and Composition of Ash

A series of tests was recently made at the experimental station of the University of Illinois by Messrs. Parr and Wheeler for the purpose of determining the heat values of pure coal. By "pure" or "unit coal" is meant the organic material involved in combustion as apart from the extraneous and variable matter such as ash, moisture, sulphur, carbon dioxide and chlorine.

This involved the correct determination of the inorganic matter and its elimination, both in weight and heat value, from the total results, in order to arrive at the actual heat content per unit weight of pure coal. If the variables had been counted as a part of the actual coal it would have prohibited, by just that much, any uniform heat values being accredited to unit coal.

Again, it being found that the unit coal of a given vein ran comparatively uniform, the above method forms a constant basis for all future determinations.

Coal with an ash of unknown composition should be examined for carbonates and chlorides. If the combined amount of these constituents approximates 0.5 per cent., the ash determination should be made at a temperature sufficiently high for their complete elimination, and a correction made for the ash value thus found by adding the amount of carbon dioxide and chlorine.

Apart from these corrections a factor for hydration is also necessary, amounting to 8 per cent. of the ash as determined minus the ferric oxide resulting from the decomposition of the iron pyrites.

The above corrections were embodied in the two following formulas, which are easy of application:

For coals free from carbonates and chlorides

$$Unit\ B.t.u. = \frac{Indicated\ dry\ B.t.u. - 5000\ S}{1.00 - (1.08\ Ash + \frac{22}{40}\ S)}$$

For coals with carbonates and chlorides

$$Unit\ B.t.u. = \frac{Indicated\ dry\ B.t.u. - 5000\ S}{1.00 - [(Ash\ at\ high\ temp. + CO_2 + Cl)\ 1.08 + \frac{22}{40}\ S]}$$

The expression "5000 S" has been used as indicating the heat due to the combustion of sulphur for the reason that the ordinarily used 4050 S represents the heat of combustion of pure sulphur, while the heat of combustion of sulphur in the form of pyrites, FeS_2, combines also the heat evolved in the formation of iron oxide, Fe_2O_3. It is, therefore, the resultant value of the several reactions that is desired and which is represented by the 5000 S.

The factors in the divisor of the above formula were derived as follows:

The atomic ratio of iron to sulphur in iron pyrites (FeS_2) is 56 : 64; that is, seven-eighths of the total sulphur is equivalent to the pure iron present.

The atomic ratio of the oxygen of the ash, combined as Fe_2O_3 to the total sulphur which it replaces is 48 : 128; that is, three-eighths of the total sulphur is equivalent to the oxygen present in the ash, combined as Fe_2O_3; hence the ash as weighed may be corrected for the iron pyrites, FeS_2 burned to Fe_2O_3, by subtracting from the ash ten-eighths of the weight of sulphur as determined. This remainder, therefore, is considered as the shaly and carbonate constituent upon which the 8 per cent. of water of hydration, carbon dioxide, etc., are calculated. The expression then becomes

$$Noncoal = Moisture + (Ash,\ including\ CO_2\ and\ Cl) + \tfrac{5}{8}\ S + 0.08\ (Ash,\ etc., -\tfrac{10}{8}\ S)$$

Clearing of fractions and combining

$$Noncoal = Moisture + 1.08\ (Ash + CO_2 + Cl) + \tfrac{21}{40}\ S$$

The expression 21/40 S is increased to 22/40 S to take care of several factors not readily embodied in the formula.

In the above formulas, dry coal only is considered, hence the moisture factor is omitted.

The CO_2 Game Now On in Boston

John E. Carroll is attempting at Boston the game he worked in Philadelphia some three years ago. Many of our readers will perhaps remember our exposé of his CO_2 motor and subsequent events in relation to the publication of the article. Our New England friends will be interested in the following correspondence of recent date.

The accompanying correspondence regarding the Carroll Carbonic Acid Gas Engine which is being exploited in Boston is self-explanatory and may save our New England friends money.

OFFICES OF POWER
New York, N. Y.
May 3, 1910.

Auerbach-Hill & Co., Underwriters,
53 State Street,
Boston, Mass.

Gentlemen:

One of our subscribers has sent me a copy of your advertisement in the Boston *Sunday Post*, exploiting the Carbonic Engine Power Company. Mr. Carroll undertook to float the CO_2 motor in Philadelphia in the summer of 1907, and is now under indictment by the State of Pennsylvania for obtaining money under false pretenses. What he claimed at that time is a scientific and physical impossibility and his "demonstration" would not mislead a boy with a common-school knowledge of physics. This demonstration was set forth in its true light in an article in the September, 1907, issue of POWER. As the author of that article I was indicted on Mr. Carroll's complaint for criminal libel, and the judge directed the jury to find a verdict in my favor, remarking that it was not only my privilege but my duty to publish such an article.

Energy is just as uncreatable as matter. No machine nor device can give out more energy than is put into it. Carbonic acid is not a "source of great energy and power." It is the dead product of the combustion of carbon, and will do no more than give back such energy as is put into it, just as will air or water vapor or a spring when put into compression.

If Mr. Carroll is running an engine with carbonic-acid gas the engine runs only by virtue of the energy which has been stored in the gas by compressing it, and when his store of compressed gas is gone his engine will stop. Any mechanical engineer of reputation will tell you that Mr. Carroll's device is on the order of the Keely motor. A sufficiently thorough investigation of it by a competent engineer will prove it an imposition. An investigation of his record and methods will prove him a charlatan who seeks to live upon the gullibility of the small investor.

Your continued exploitation of such a manifest swindle will result in more injury to your reputation than any immediate profit can offset.

Yours very truly,
F. R. Low,
Editor.

DISTRICT ATTORNEY'S OFFICE
Philadelphia, Penn.,
April 27, 1910.

F. R. Low, Esq.,
POWER AND THE ENGINEER,
505 Pearl Street, New York City.

My dear Sir:

Replying to your letter of the 23d instant, I beg to advise you that there are still pending in this county several indictments against John E. Carroll, which we hope to dispose of within the very near future. The trial of these indictments has been delayed for causes beyond our control.

Yours very truly,
(Signed) SAMUEL P. ROTAN,
District Attorney.

LAW OFFICES
N. E. Corner 13th and Chestnut Streets,
Philadelphia, Penn.,
April 27, 1910.

Commonwealth vs. Carroll.

Mr. F. R. Low,
Editor, POWER,
505 Pearl Street, New York.

Dear Mr. Low:

Your letter of the 25th inst. is at hand this morning. Carroll is under indictment and awaiting trial in Philadelphia for obtaining money under false pretenses.

I am now awaiting an answer from our principal expert witness, who is located in the West, in order to make an appointment with the district attorney for early trial of the charge against him. I trust that the arrangements for trial can be consummated very shortly.

Yours very truly,
(Signed) E. SPENCER MILLER.

Emergency and the Man

By L. M. Leslie

At a recent engineers' meeting the subject "What to do in cases of emergency" had been discussed, and as the interest lagged, the presiding officer changed the topic from "What to do" to "What *did* you do in an emergency" and called upon various members to relate their experiences.

One member arose and said: "I am prompted to relate an incident in my engineering career for which I have been both severely criticized and highly praised. At the time I was assistant engineer at a lighting plant that included among its equipment one 500-kilowatt direct-connected Corliss engine and one shaft-governed engine belted to a 250-kilowatt three-phase generator. During the early evening load it was customary to run both generators coupled together in parallel, though at the first indication that the load was dropping off, No. 2 engine would be disconnected from the board and shut down. On the night in question, the load seemed to have fallen off a little earlier than usual.

"Having pulled out No. 2 oil switch, and also the field switch, I adjusted No. 1 rheostat, and was surprised that it needed considerably more cutting out in order to hold up the voltage. Just then an unusual noise in the direction of No. 2 engine attracted my attention, and I saw at a glance that it was running away. The throttle valve was fully 100 feet from the board and as I started to run toward it, the conviction seized me that I would never be able to shut it in time to save the flywheel. But something had to be done, and must be done quickly. I retraced the few steps I had taken, closed the field switch, and threw in No. 2 oil switch. Instantly there arose a tremendous groan from the generators, and a piercing prolonged shriek from the belt; the ammeter needles madly oscillated, and for a moment the lights dimmed to a low red. Then they quickly brightened up again, and the ammeter needles gradually became steadier; the fight was over and I had won.

"When the governor of No. 2 engine was examined a check nut holding one of the arms was found to have backed off and so lodged in a pocket above the arm as to prevent the governor weights from assuming their highest position though they were free to regulate the speed of the engine when it carried half load or over."

Inquiries of General Interest

Specifications for Smokestack

Will you give me an idea as to the proper specifications for a sheet-iron smokestack 36 inches in diameter by 60 feet high?

J. H. B.

It should be specified in the contract that the stack shall be 36 inches in diameter and 60 feet in length. That each course shall be 5 feet in width and in one piece. That all of the courses except one shall be 3/16 inch thick, the exception to be ¼ inch thick, and this thicker course to be the fourth from the top end of the stack. That it shall be made in two sections, each 30 feet long with rivet holes correctly spaced for joining the sections before erection. That at the bottom and at the top there shall be riveted a closely fitting band of iron ⅜x2½ inches. That a guy band of iron ⅜x2½ inches with provisions for the attachment of four guy ropes be fitted to the ¼-inch course. That there be furnished with the stack four guys of ½-inch diameter galvanized-steel wire guy rope furnished with suitable thimbles, clamps and turnbuckles and of a length that will reach the predetermined points of anchorage. That in the bottom course there shall be placed a damper 3/16 inch thick with lever and handle. That there shall be attached to the top of the stack a painters' block provided with 120 feet of flexible galvanized gantline. That there shall be furnished a base plate 1 inch thick of cast iron with flange around the central opening projecting upward 1½ inches and closely fitting the inside of the bottom course and an outside flange extending downward ¾ inch to protect the brickwork. That all rivets shall be ½ inch in diameter, pitched 3½ inches from center to center. That the stack when complete shall be given one coat of black asphaltum paint, and also that all material and workmanship shall be of the best quality.

Engine Dimensions

I wish to make a small engine with a cylinder 3 inches in diameter. What should be the sizes of crank shaft, pins, etc.?

R. S. J.

Make the shaft one-half the diameter of the cylinder and the main journal two diameters in length. The crank and crosshead pins should be one-half the diameter of the shaft and one diameter long. The length of connecting rod should be three times the length of the stroke. Steam pipe one-quarter and the exhaust pipe one-third the diameter of the cylinder.

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it.

Five Ports in Steam-pump Cylinder

What reason is there for a steam pump having five valves?

E. F. C.

This question should probably be, Why have some steam pumps five ports? If the valve of a duplex pump be lifted from its seat, it will be seen that there are five openings or ports, two of which connect the cylinder with the steam chest and two connect the cylinder with the fifth or exhaust port by means of the chamber in the middle of the valve. By the use of the two extra passages leading to the exhaust port a much shorter valve travel is needed and provisions for compression to any desired point may be made. Each steam port is connected by a passage through the bridge to the adjoining exhaust passage. This opening is controlled by a valve by which much or little of the steam caught in the cylinder as the piston passes the exhaust passage may escape by the way of the steam port through the connecting passage into the exhaust.

Compression and Riding Cutoff

If an engine with a riding cutoff valve had too much compression, how could it be altered?

J. B. A.

Compression in an engine cylinder depends on the point of exhaust closure and not on the point of cutoff. As the riding cutoff determines only the point at which steam is shut out of the cylinder, it can have no effect on compression. This can be changed only by altering the amount of inside lap on the main valve.

Altering Point of Cutoff

How can the point of cutoff on a Corliss engine be altered?

T. A. H.

By altering the load or the steam pressure. In all engines where the regulation depends on the length of time that the steam valves remain open, the point of cutoff depends upon the load and steam pressure and changes automatically to fit the conditions. In slide-valve engines the point of cutoff may be changed by changing the amount of lap.

Cause of Losing Vacuum

What causes a compound engine to lose its vacuum and what makes the low-pressure side pound when the vacuum is lost?

B. P. C.

It is the condenser that loses the vacuum, and in the majority of cases it is caused by the lack of sufficient cooling water, though excessive air leaks through pipe joints and stuffing boxes will impair if it does not destroy it. Without the vacuum a higher receiver pressure will prevail and the lead which is right for say 10 pounds receiver pressure will be altogether too much for 15 or 20. Sometimes excessive compression will force the steam valve off the seat, causing a disagreeable sound as it returns.

Smokestack Dimensions

I have two boilers of 100 horsepower each and one of 150 horsepower with stacks 30 inches in diameter and 50 feet high. The draft is poor. Will adding to the hight improve the draft?

H. A. J.

Adding to the hight will improve the draft some, but the stacks should be larger as well as higher. For the 100-horsepower boilers they should be 33 inches in diameter and 80 feet above the grates. For the 150-horsepower boiler the stack should be 38 inches in diameter and 100 feet high, or a single stack 4 feet in diameter and 110 feet high should be put up for the three boilers.

Net Area of Piston

What is meant by the net area of the piston?

A. C. D.

The net area of the piston is the area exposed to pressure, that is, it is the area of the piston minus the area of the piston rod. Where allowance is made for the area of the rod it is customary to subtract one-half the area of the rod from the area of the piston and call the remainder the area of the piston instead of subtracting the whole area from one side only of the piston area.

Effect of Giving Valve Inside Lead

What effect will it have if a valve is given inside lead?

A. B. M.

If by inside lead it is meant that the valve has negative lap, the exhaust will open earlier and close later in the stroke.

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Power and The Engineer

Editorial

The Consulting Engineer

The field of usefulness and profit that is open to the trained and persevering mechanical engineer, who enters the field of consulting engineering is indeed broad. His duty usually consists of applying power to accomplish the purpose of his clients in the most economical manner possible, and this requires a broad training.

But one of his most important qualifications should be, honesty.

Let us nip in the bud any conception that this is to be a sermon on the pernicious influence of graft by asserting our glad belief that the rank and file of consulting engineers would never think of stooping to this form of dishonesty.

There is, however, a form of dishonesty practised to a large extent by consulting engineers, which is often of more injury to a client's interest than the acceptance of graft, and is also entirely devoid of profit to the consulting engineer. It masquerades under various names such as originality, bull-headedness, self-esteem and others of similar meaning. In any undertaking that is of sufficient magnitude to warrant the services of a consulting engineer, there is always ample opportunity for the display of originality in planning and supervising the general arrangement and use of apparatus, and in deciding which of the various offerings of standard apparatus is best suited to economically accomplish the purpose in view. It should be a self-evident fact that no engineer, regardless of his qualifications, can possibly be an expert in designing the details of all the apparatus that enters even a small installation, and that a mediocre designer, who has devoted his entire time and talent to one line, will usually outclass, in that line, the engineer of broader knowledge.

To present a concrete example of how a client's interest is often dishonestly abused, we will take the case of the boiler equipment for a plant constructed under the supervision of a consulting engineer of the kind we have in mind. After due consideration, the engineer decides that the return-tubular type of boiler is the one best suited for the plant in question, and at this point he apparently reasons about as follows: If he should draw up a customary specification, covering only the points necessary to obtain a safe and durable boiler, and caring for the details of construction by seeing that the order is placed with a reputable manufacturer, or by having the manufacturer submit details of construction for his approval, he will lose all identity with the installation and be called a "catalog engineer." In order to avoid this ignominious fate he decides that he will design the boilers himself so as to obtain the best construction possible for the service contemplated, using as a clincher in the argument to his client that often misapplied simile, that there will be the same difference between the design he will evolve and the usual manufacturers' product as that between the tailor-made suit and the "hand-me-downs."

He now proceeds to draw up specifications and make drawings describing minutely every detail of construction, and not being a practical boilermaker, he usually prescribes impossible construction at many points and conforms to standard practice at none. The seams he designs are often difficult to make tight, because of his endeavor to obtain a theoretically high efficiency, without regard to practical conditions. The layout of bracing interferes with accessibility, every detail of construction is special and the boiler cannot be built by any manufacturer except at a considerable advance in cost above that of standard construction. Manhole sizes and shapes are special, causing, in addition to the increased cost of manufacture, continual expense and trouble in operation owing to the difficulty of obtaining special gaskets. If the client has a good idea of usual prices for the apparatus required, and becomes inquisitive about the increased cost, he is at once quieted with the assurance that the high price indicates the extra quality of the apparatus he is obtaining under the skilful guidance of the engineer, as compared with that regularly furnished by the manufacturer. This explanation is almost invariably false, for standard apparatus developed by a reliable manufacturer of experience generally represents maximum value for the cost involved.

Another point which is not just to the manufacturer is that after drawing up rigid specifications intended to cover every point of construction, the manufacturer is specified to be solely responsible for defects of design and to guarantee economical performance, notwithstanding

the fact that he has absolutely nothing to do with the design.

It is distinctly dishonest for a consulting engineer to saddle the expense of experimental design of standard apparatus on a client, unless his client thoroughly understands the situation and approves of the course advised. It is generally noted that the volume of business done by a consulting engineer is in an inverse ratio to his originality, when of the kind to which we have here referred.

The Steam Turbine in Modern Practice

On page 906 we reproduce a letter from one who, evidently, is "from Missouri"; he wants to be shown. Recently, we published some abstracts from the paper, "The Steam Turbine in Modern Practice," which was read at a joint meeting of the American Society of Mechanical Engineers and the St. Louis Engineers Club. Our "Missourian" questions the authenticity of some of the statements uttered, as anyone well might who had not familiarized himself with the progress made in turbine practice, for at first blush they do seem to be incredible.

In commercial use the turbine is a modern institution. The original turbine installation at the Fisk street station was made in 1903. It consisted of three 5000-kilowatt machines. These were the first of this size to be installed in America. Their steam consumption was relatively high. The machines which replaced them were the most modern of their type and had a much lower steam consumption. While the steam used by one 12,000-kilowatt turbine is, of course, much greater than that which was required by one of the 5000-kilowatt machines, the difference in the total quantity of steam required is not in proportion to the difference in capacity. This and the fact that modern boiler practice has proved that it is cheaper to drive boilers at a rate greatly in excess of their rating than to install additional boiler capacity which would be idle during the long light-load intervals, explain how it is possible to obtain a much greater electrical output without increasing the number of boilers.

The capacity of a turbine is increased by adding more nozzles, or, in other words, by making the quantity of steam admitted per unit of time greater.

It will be understood, then, that change in design and a greater rate of speed make it possible to increase the capacity of a turbine without increasing the ground area required. The condensers of the original 5000-kilowatt machines were replaced by surface condensers located in the bases of the new units.

At St. Louis, the increase in capacity without increase in base area was accomplished in the same manner as at Fisk street. The original condensing equipment of the St. Louis plant was ample, so that by increasing the quantity of circulating water the vacuum could be maintained for the more economical 12,000-kilowatt machines. In this case, also, while the boilers were undoubtedly called upon to deliver a greater quantity of steam, the increase was not great enough to exceed their maximum output. The use of the same size of steam piping simply necessitated an increased steam velocity.

At the Interborough station in New York City, low-pressure turbines were installed to operate on the exhaust of compound reciprocating engines at very nearly atmospheric pressure. When it is considered that steam is capable of doing as much work when expanding from fifteen pounds absolute pressure down to one pound as when expanding from two hundred and twenty-five pounds down to fifteen, it is not unreasonable to expect an increase in over-all economy of twenty-five per cent. to result from the use of low-pressure turbines which use the expansive force of low-pressure steam much more economically than do reciprocating engines.

Elaborate and careful tests of the engine-turbine units at the Interborough plant were conducted under the direction of Henry G. Stott. The results of these tests were fully set forth in a paper presented to the American Society of Mechanical Engineers and the American Institute of Electrical Engineers on March 8. Abstracts from this paper were published in POWER for March 15. The best water rate for the engine alone obtained during these tests was 17.07 pounds per kilowatt-hour, while the best rate for the combined engine and turbine unit was 13.19 pounds per kilowatt-hour. The average improvement in economy, between the output limits of 7000 and 15,000 kilowatts, was twenty-five per cent.

A Neglected Advantage for Motor Driven Factories

In the discussion at St. Louis of the papers on motor drive recently presented to the national electrical and mechanical engineering societies jointly, an engineer of the Western Electric Company mentioned an important advantage which is obtainable in establishments driven by alternating-current motors but which is not commonly utilized. That is the use of some direct-current motors supplied from a motor-generator set, the motor of which is a synchronous machine. The synchronous motor, whether loaded or running free, could be overexcited to improve the power factor of the alternating-current system, and the direct-current motors supplied from the dynamo end of the set could be used to advantage wherever it is necessary to have variable speeds or other characteristics which are obtained more readily from direct-current than from alternating-current motors.

The suggestion was an excellent one, and tempts one to speculate at length upon its possibilities. It would not be necessary, however, to use a motor-generator at all; a rotary converter would serve the purpose exactly as well at higher efficiency and lower first cost and maintenance expense. In an establishment large enough to justify consideration of the problem at all, even if variable-speed machine-tool motors were not needed there would be cranes and hoists, which are much better equipped with direct-current series-wound motors than with any kind of alternating-current machine. The fact that these might not be operated continuously would not affect the value of the converter as a power-factor improver, whilst it would confer the advantage of making the extra power conversion intermittent.

Even the bogy of nonuniformity of motor types could not be urged strongly against the use of direct-current motors for hoisting and similar service, with induction motors elsewhere throughout the shops, because an alternating-current motor of the type best adapted for hoist service would not be "uniform" with the general-purpose induction motor to a sufficient extent to affect the questions of interchanging motors and carrying spare parts.

In numerous instances it has been stated in print and by word of mouth by those interested in the promotion of the Rhode Island coal-mining industry or the sale of stock in the mining corporation that it was intended to offer the coal not for industrial uses but for domestic consumption. A side light on this statement gives it a shade of truth. Not long ago, a stranger waiting at the Portsmouth station for a train to take him to Fall River overheard an employee of the mining company complaining about the nonarrival of a consignment of coal, saying as he finished, "If that coal does not come today the mine will have to shut down."

Rules o' thumb undoubtedly perform a useful function, but plenty of common sense must be exercised with their use, else they may prove to be worse than useless.

The next time you are feeling a little superior to other engineers, look yourself over and figure out how many times you have made a fool of yourself.

Many good engineers had mighty poor material to begin with.

New Power House Equipment

Variable Speed Device for Paper Mills

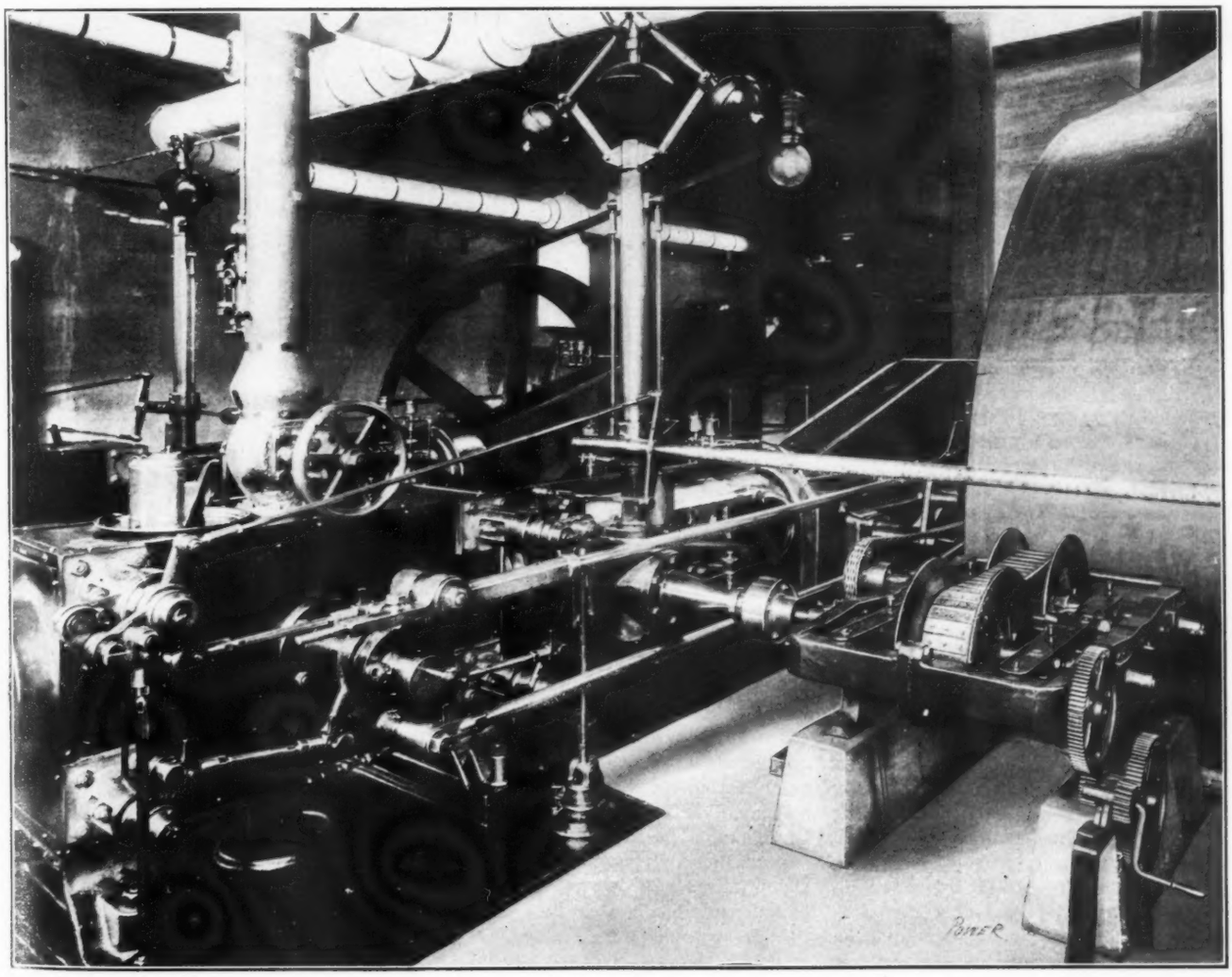
What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news.

It is doubtful whether there is any duty expected of an engine in the entire field of power production in which the requirements are so severe, in regard to speed variations, as in paper making.

While electric motors, gas engines and other forms of prime movers have been applied to this work, still the desirability of the steam engine will be apparent, when it is understood that for every pound of paper made, 3½ pounds of steam are required in its manufacture. Thus the two go together, the necessary steam being a byproduct of the power required to make the paper. Heretofore, however, it has not been feasible to get variable speeds from a Corliss engine, although this type of engine would be desirable in this service if it could be applied.

It was with these facts in view that the Hooven-Owens-Rentschler Company, of Hamilton, O., brought out the variable-speed device shown in the accompanying illustrations, to be applied to its standard Corliss engine for paper making. This consists, as is evident in the illustration, of a simple speed-changing equipment, belted to the main shaft of the engine and driving the governor direct. With this device any reasonable speed variation may be obtained and the Corliss engine can be applied to the paper-making industry without the use of the cumbersome devices sometimes employed which transmit the entire power of the engine. It is obvious that this simple, light, variable-speed equipment is much easier and cheaper to maintain than the old form of apparatus. Moreover, the speed control may be made from a distance by providing suitable rope connections so that the operator at the machine has entire charge of its speed variations. This equipment is in satisfactory use at a number of paper mills throughout the country.

A recipe for cleaning and polishing brass reported to give good results is as follows: One pint sperm oil; one-half ounce comphor gum, pulverized; one-half ounce oxalic acid, pulverized; one-half ounce arsenic; two ounces fine emery flour; tripoli to thicken to a paste. Place the sperm oil in a can or bucket, set it over the fire, bring the oil to a slow boil; place the camphor gum and oxalic acid in the hot oil, stir until entirely dissolved, when add tripoli, emery and arsenic; use tripoli enough to make a thick paste. This will always stay as a paste and not get hard.



VARIABLE-SPEED DEVICE APPLIED TO CORLISS ENGINE

Steam and Air Flow Meters

The recording and indicating steam meters, manufactured by the General Electric Company, Schenectady, N. Y., have been designed to show the amount of air, steam, or other fluids being delivered for any particular purpose.

The type R, form D, recording flow meter, shown in Fig. 1, records the rate

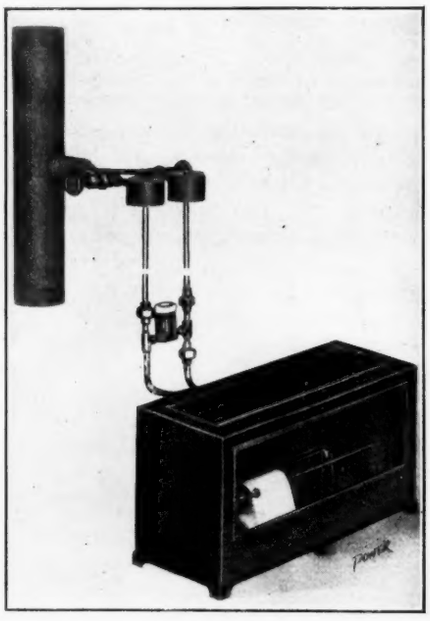


FIG. 1. RECORDING STEAM FLOW METER WITH AUTOMATIC PRESSURE CORRECTION

of flow of steam in pounds per hour, in pipes of any diameter, and any condition of temperature, pressure or moisture met with in commercial practice. The instrument is designed to give an accurate record on periodically intermittent flow, such as occurs in operating reciprocating steam engines, pumps, etc., as well as on constant flow of steam, providing it is recalibrated after being installed, or the arrangement of the piping permits inserting the nozzle plug, shown in Fig. 2, at a point in the steam main where the flow of steam is constant.

FIG. 2. NOZZLE PLUG FOR FLOW METER

The meter always remains cool, as none of the steam being measured passes through it. It can be placed at any point in the plant so long as it is on a lower level than the nozzle plug.

The services for which the meter is adapted are that of recording the total amount of steam generated by a boiler or battery of boilers, recording the amount of steam delivered to any department of a manufacturing plant and recording the amount of steam sold for power, heating or manufacturing purposes.

It also enables the equalization of load on individual boilers of a battery, and is a means of discovering losses due to leaks between the boiler and the point of consumption. It may also be used to determine the deterioration of efficiency of a boiler due to the formation of scale, besides being a means of determining the efficiency in the method of stoking.

The meter consists of two cylindrical hollow cups filled to about half their hight with mercury. The cups are joined together at the bottom, forming a U-tube which is supported on and free to move as a balance about a set of knife edges.

A difference in pressure in the nozzle plug is communicated to the cups by flexible steel tubing placed within the case. This difference of pressure causes the mercury to rise in the right-hand cup and fall in the left-hand cup until the unbalanced column of mercury exactly balances the difference in pressure.

By this displacement of the mercury, the beam carrying the cup moves downward on the left-hand side of the knife edges until the movement of the weights on the right of the knife edge exactly balances the moment caused by the displacement of the mercury in the right-hand cup. The movement of the beam is multiplied by levers and actuates a pin which moves in proportion to the amount of mercury displaced.

The recording drum feeding the paper is driven by an eight-day clock. The paper on which the record is made is so calibrated that the rate of flow in pounds per hour may be read at any instant, or the average rate calculated for a given time.

For compensating for variation in pressure and temperature a hollow spring is provided, similar to the pressure spring in a steam gage, and is connected so as to be influenced by the steam pressure at the point where the flow is being measured. Any variation of the static pressure causes the spring to extend or contract, and this movement actuates a small correction weight in such a manner as to affect the deflection of the pin so that the indicated rate of flow recorded is correct for the pressure existing in the steam main. Fig. 3 shows this recording meter with the automatic pressure-correction device attached thereto.

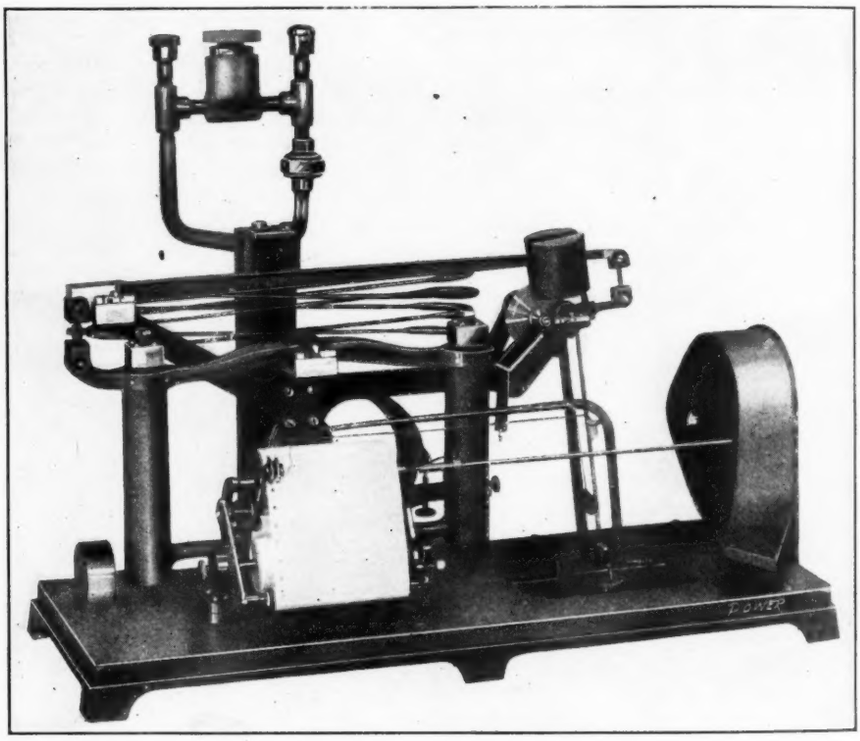


FIG. 3. RECORDING STEAM FLOW METER WITH AUTOMATIC PRESSURE CORRECTION

Compensating for temperature variation is made by an independent hand adjustment of this same correction weight which corrects the reading for pressure fluctuation. This adjustment is made by increasing or decreasing the distance of the correction weight from its point of suspension, and this distance is determined from a chart sent out with each meter. When the temperature and pressure of steam are practically constant, the recording-flow meter is not fitted to the automatic pressure-compensating device.

Another design of meter is known as an indicating-flow meter, type I, form F. This meter has been designed for indicating rather than recording the flow of steam, gas or air, and is found especially useful for testing work, locating troubles due to leaks, etc. It will register at any

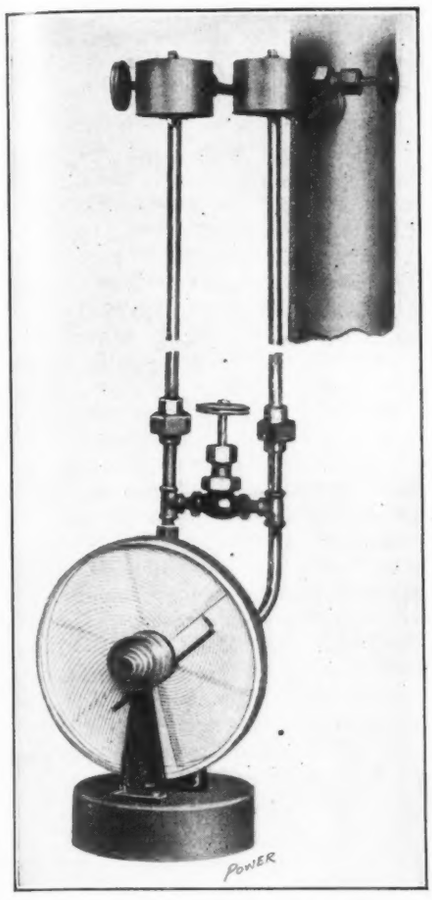


FIG. 4. INDICATING FLOW METER

condition of temperature, pressure or moisture met with in commercial practice. When measuring a steam flow, it is said to give a true indication of the instantaneous rate of flow in pounds per square inch of pipe cross-sectional area.

If used to measure air the units are recorded in cubic feet of free air at 70 degrees Fahrenheit. The same meter cannot be used alternately for measuring steam and air flows. The meter is portable and is provided with a leather carrying strap.

Use is made of the nozzle plug for obtaining a difference in working pressure proportional to the velocity, in the same manner as in the recording meter. If the temperature and pressure of the gas be constant, the rate of flow in the pipe will be proportional to the velocity. To measure the velocity, a nozzle plug, Fig. 2, is screwed into the pipe at the point where the flow is to be measured. One set of openings, known as the leading set, extends horizontally across the steam main and faces against the direction of flow. The other three openings near the center of the plug constitute the trailing set. The steam impinging against the leading set of openings sets up a pressure in them which is equal to the static pressure plus the pressure due to the velocity head. The pressure in the trailing set is equal to the static pressure minus a pressure due to the velocity head. This difference of pressure existing in the two sets of openings is communicated through separate longitudinal chambers to the outer end of the plug, and from there by proper piping to the meter.

The meter itself consists of an iron casting which is cored out to form a U-tube, as shown in Fig. 4. This is filled for a part of its hight with mercury or water, depending on whether the meter is to be used for measuring steam or water. A difference in pressure in the nozzle of the plug causes a difference of level of the liquid in the U-tube. A small float, suspended by a silk cord, actuates a pulley over which the cord passes. The pulley in turn moves a small bar magnet on the end of the shaft next to the dial in proportion to the change in level of the working fluid in the U-tube.

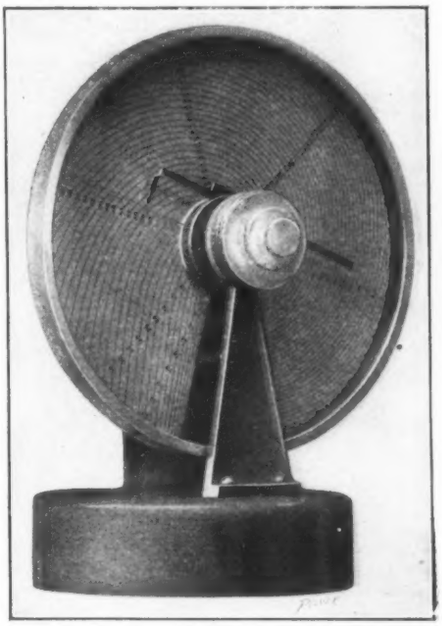


FIG. 6. DISK OF INDICATING STEAM OR AIR FLOW METER

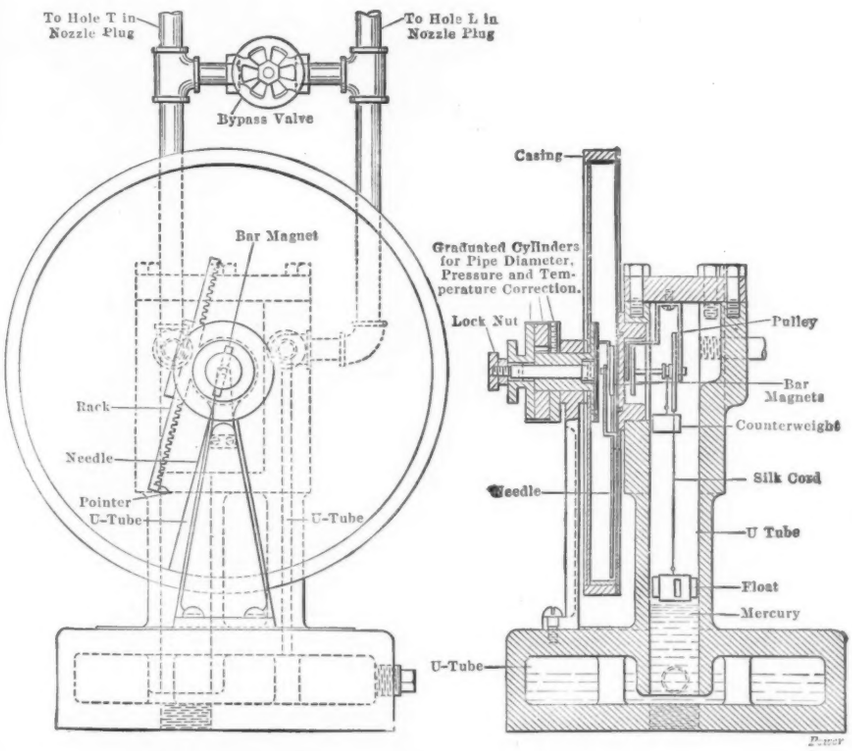


FIG. 5. DETAILS OF INDICATING FLOW METER

The indicating needle is mounted in a separate cylindrical casing. On the inner end of the needle shaft another bar magnet is mounted, which is free to turn in the same plane as the magnet on the inside of the meter casing. The mutual attraction of these two magnets keeps them always parallel, and the necessity of a packed joint in transmitting the motion of the pulley to the indicating needle is eliminated.

The dial can be rotated until the indicating needle reads zero when the valve in the bypass is open. Opening the valves also prevents the blowing out of the working fluid in the U-tube by excessive pressure in either leg. By referring to Fig. 5, it is seen that the proper adjustments of pipe diameter, temperature and pressure are readily made by setting the graduated cylinder, which actuates the rack carrying the pointer. When these settings are made, the rack is rotated by hand until the pencil coincides with the indicating needle. The point on the graduated scale at the intersection of the needle and pointer, Fig. 6, gives the true instantaneous rate of flow in square inches of pipe area.

Motor Driven Multivane Forge Blower

The blower shown in Fig. 1 is composed of a pressure fan of the multivane type, inclosed in a pressed steel-plate casing, driven by a direct-connected electric motor built to operate from electric-lighting circuits.

The particular features of this blower set are compactness and high efficiency, said to be due largely to the multivane type of wheel, shown in Fig. 2.

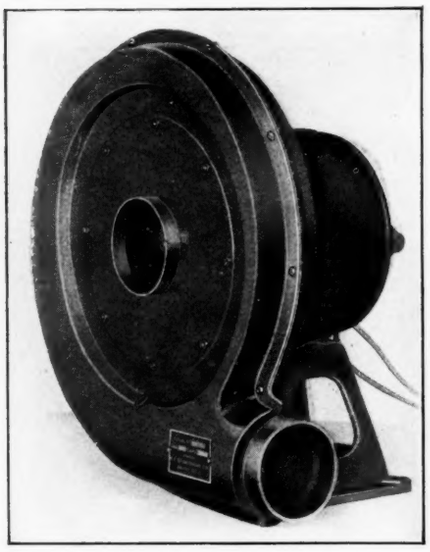


FIG. 1. MOTOR-DRIVEN FORGE BLOWER

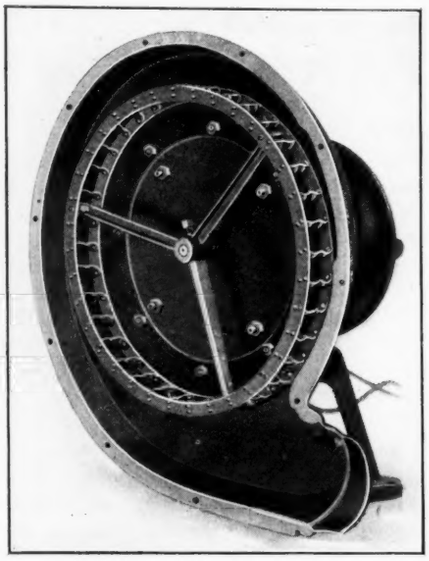


FIG. 2. MULTIVANE TYPE OF WHEEL

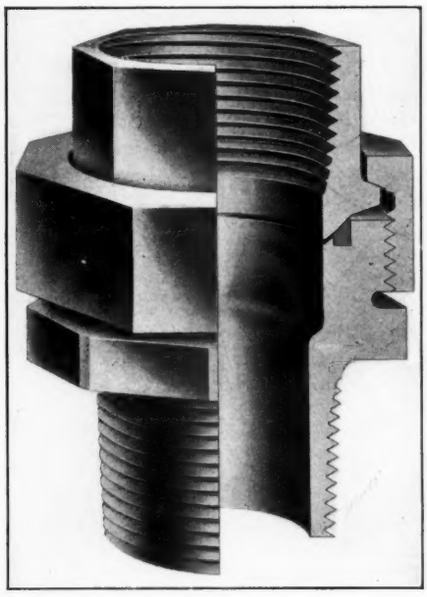
This blower can be set on a bench or shelf and the pipe run to the tuyere, or it can be set on a box or floor near the forge and be connected by piping, or if desired, can be bracketed to the forge and discharge directly into the tuyere. The casing can be turned to discharge in any desired direction.

The set weighs complete 35 pounds and measures 14½ inches from the floor to the top of fan case and 10 inches from the inlet of the fan to the outside end of the motor shaft.

The set is made by the B. F. Sturtevant Company, Hyde Park, Mass.

The Jefferson Male and Female Union

Using a male and female union eliminates a nipple, an extra joint is avoided, and a shorter connection can be made. This union, known as style "F," is made by the Jefferson Union Company, Lexington, Mass. It is made with a spherical-ground brass-to-iron-joint. A brass ring firmly embedded in a channel in the male part of the union forms the seat. The wrought seat ring is cut from seamless brass tubing. The brass-to-iron joint is used because it is noncorrosive. All the rest of the fitting is made of malleable iron.



JEFFERSON UNION

The iron shell absorbs the heat and distributes it through the iron so that much less heat reaches the brass ring than would be the case if it were in direct contact with the hot fluid or steam passing through the union.

No gasket is used, as the brass ring is cut to fit the spherical end of the opposing member, and the two parts ground together.

This male and female union can be used for short connections where the ordinary union and nipple would be impossible. Any style of wrench can be used on any of the three parts, because the octagonal, flat surfaces are so arranged that there is no interference, one with the other. On the clamping nuts the flat surfaces are outside, clear of the corners of the part having the external threads. On this latter part the flat surfaces are outside and clear of the nut threads. On account of the manner of fitting the brass seat in place, it is impossible to injure it by screwing the pipe too far into the union.

Imqroved Parsons' Turbine

The only turbines which are practically exempt from leakage losses arising from the clearances allowed between the revolving and stationary parts are those of the single-stage impulse type, and with a view to minimizing the leakage which at present occurs, the Hon. C. A. Parsons has designed a turbine, which is illustrated in diagrammatic form herewith. As will be seen, the space between the rotating and fixed members is so constructed as to form an annular jet, or one or more segmental jets, practically the whole pressure drop at any stage taking place at this point, and the pressure fluid impinging upon blades of any suitable type to absorb the velocity generated. The turbine is thus divided into a series of pressure stages, each stage having one or more rows of guide and rotating blades upon which the steam from the preceding restriction impinges. In order to obtain the best results it is

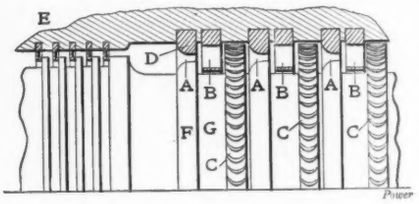


DIAGRAM OF TURBINE

desirable that the number of rows of blades per stage shall be small. Referring to the illustration, which shows part of the casing in section and part of the rotor in elevation, *A*, *A* and *A* are the annular restrictions, formed by a barrier strip *D* secured to the casing *E*, opposite to a similar strip *F* secured in a groove in the turbine drum *G*. The adjacent faces of these strips leave an annular space of such a form as to allow for an expansion of the working fluid to occur. From the first restriction *A*, the working fluid passes through a ring of guide blades *B*, which may be of the Parsons or any other convenient type. From these guide blades the steam is directed against a row of rotating blades *C*, which are preferably of crescent or cup form. From these rotating blades the steam is passed through another annular jet *A*, of slightly larger area, and is further expanded to impart suitable velocity for the next stage, which may consist of a ring of guide blades *B*, and a ring of rotating blades *C*, of the same character as those in the first section. This action may be repeated as many times as desired through the turbine.—*Mechanical Engineer.*

Adjustable Cover and Boiler Blocks

Boilers set with brick in the ordinary manner are not easily kept free from an accumulation of soot, and the top plates are, in many cases, never seen after the boiler has been installed, because of the trouble and expense necessary to make an examination. The adjustable cover and boiler blocks illustrated herewith are made by the Adjustable Cover and Boiler Block Company, 64 Victoria street, Westminster, London. In this country the Company is represented by P. E. Whitehurst, 500 Fifth avenue, New York City.

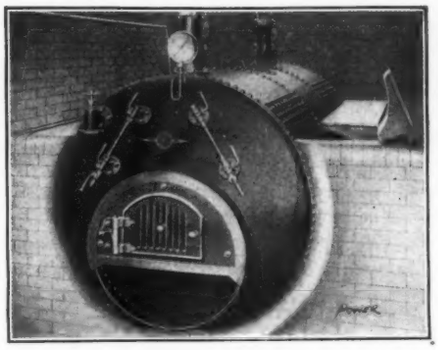


FIG. 1. CORNISH BOILER SET WITH COVERS AND BLOCKS

This system permits of a quick removal of the covering of a boiler so that the plate can be examined, in the case of a return-tubular boiler, or the tubes of a water-tube boiler. A gas-tight covering is secured, because the cover and seating block overlap each other on both sides, forming a complete barrier to cold-air infiltration and excessive radiation of heat.

Fig. 1 shows a Cornish boiler set with an adjustable cover, and illustrates how easily the boiler can be gotten at for external examination.

Fig. 2 shows a water-tube boiler set with the covers and blocks between the drums. The blocks and covers for various sections of the setting are made in different shapes and the joints between the block setting proper and the cover sections are packed with slag wool or asbestos to take up the expansion and contraction of the boiler.

In the setting of a return-tubular boiler, the brickwork is built up on the outside and lined on the inside in the regular way. Instead of drawing in at the fire line, however, the wall is fitted with the saddle block *A*, Fig. 3, which is cemented to the setting. The cover *B* rests in the saddle *A*, which extends the entire length of the boiler setting, and fits against the shell of the boiler.

These cover sections are made with overlapping edges on every other cover piece, the cover plate fitting in between. The pieces having overlapping edges are made with a shoulder so that when the plates and covers are put in place they fit together, making a double over- and underlapped joint. The two designs are shown at *E* and *F*, Fig. 4.

The rear arch is designed as shown in Fig. 5. A special-shaped cover is used, which rests on an iron bar riveted to the boiler and on the brick setting on the other end. An expansion plate fits on a flat seat on both cover and wall, which allows for the expansion of the boiler. The space between the two cover pieces is packed with slag wool.

It is said that all of the large boiler-insurance companies in the United Kingdom have given the cover blocks their hearty approval.

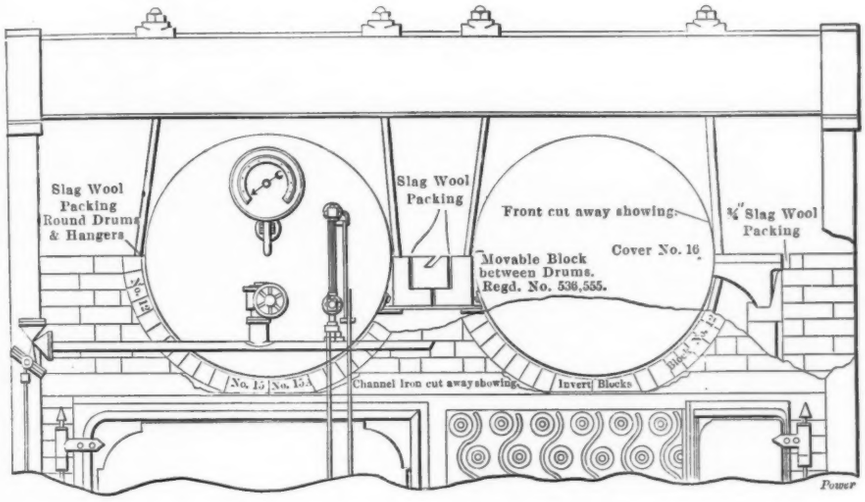


FIG. 2. SHOWING COVERS AND BLOCKS BETWEEN DRUMS OF BABCOCK & WILCOX BOILER

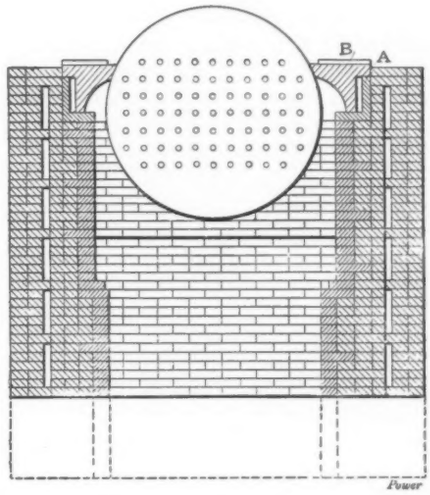


FIG. 3. COVER AND BLOCK APPLIED TO A RETURN-TUBULAR BOILER

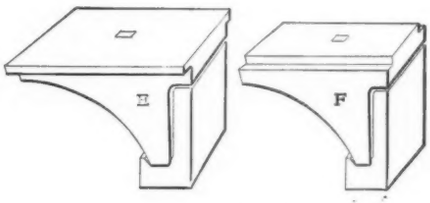


FIG. 4. DETAILS OF COVER AND BLOCK

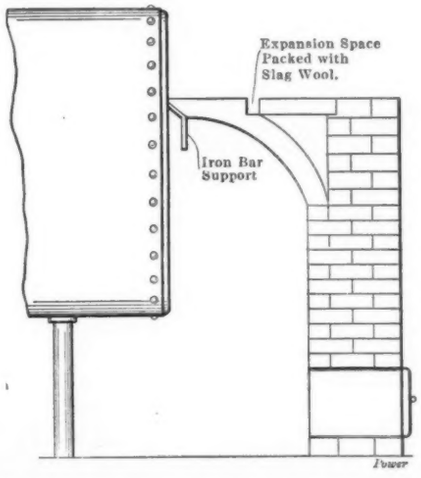


FIG. 5. COVER AND BLOCK ON BACK ARCH

The announcement that it is now possible to produce ductile metallic tungsten in the electric furnace means much for the tungsten lamp which has heretofore been hampered by its filament fragility. Under present methods of manufacture tungsten particles have been welded into a continuous filament by passing an electric current through a binding material containing the metallic particles and driven off by the high heat. By this new method the metallic tungsten can be drawn into fine wire much stronger and more rugged than the sintered filament. It is expected that the incandescent lamp made with these new filaments will not only have a longer life, but also be even more efficient than the present tungsten lamps.—*Ex.*

NEW PUBLICATIONS

ELEMENTS OF MACHINE DESIGN. By D. S. Kimball and J. H. Barr. John Wiley & Sons, New York. 446 pages; 5½x9; illustrated; cloth. Price, $3.

The prevailing conception of machine design seems to be that there exists a wide gap between theoretical and practical design, and that most machines are designed by empirical formula only. To what extent this may be true is a matter of opinion, but there nevertheless exists certain underlying principles which should be followed in all methods of good design.

The purpose of this book is to lessen the supposed gap and to show that for the intelligent proportioning of machine parts, to withstand the forces applied, a close analysis should first be made of all forces acting and the parts proportioned according to theoretical principle; this having been obtained, the design can then be modified by judgment and a consideration of the practical production of the part. While the treatment presupposes the working knowledge of mechanics it is to a certain extent self-contained.

With the idea in view that a machine is for the transmission of definite forces in the performance of useful work, considerable space is given to the consideration of energy and force. The four methods of transmitting energy with machines are given, viz.: Energy received at a constant rate and work done at a constant rate; energy received at a constant rate and work done at a variable rate; energy received at a variable rate, and work done at a constant rate; energy received at a variable rate and work done at a variable rate. Types of machines embodying these conditions are cited and their force diagrams worked out.

The design of the following is taken up in detail: springs, riveted joints, keys, pipes, cylinders, flues, axles, shafting, belts, chain transmission and gearing. No attempt has been made to go into the design of special machines as they represent, after all, only a combination of the simpler ones.

A chapter is devoted to the subject of friction, lubrication and the design of bearings, and contains many practical hints in this line.

All processes of analysis are illustrated by working out concrete problems and the text is written in a clear and concise style.

While primarily intended as a textbook for the use of engineering students, it should also find favor with the practical designer.

"Tests of Washed Grades of Illinois Coal," by C. S. McGovney, is issued as Bulletin No. 39 of the engineering experiment station of the University of Illinois. This bulletin presents the results of an elaborate series of boiler tests made in connection with a 210-horsepower brick-set water-tube boiler, equipped with a chain grate stoker. The fuel employed was washed Illinois coal of the various sizes commonly used for steam purposes. The description of the plant, the methods employed, and the results of the tests are given in detail. Copies may be obtained gratis upon application to W. F. M. Goss, director of the engineering experiment station, University of Iilinois, Urbana, Ill.

OBITUARY

The engineering profession will be grieved to learn of the death of Walter C. Kerr, at Rochester, Minn., on May 8. Up to within two months ago, at which time he started West for treatment, Mr.

WALTER C. KERR

Kerr was actively angaged in carrying on the business of the engineering firm with which he was connected.

Mr. Kerr was born at St. Peter, Minn., on November 8, 1858, and at the age of 17 entered Cornell University, taking the mechanical engineering course and graduating with the class of '79.

He was an instructor for one year and later became an assistant professor, which position he held for two years. He then went with the Westinghouse Machine Company as a salesman and soon became manager of their Eastern sales office. In 1884 he helped to organize the firm of Westinghouse, Church, Kerr & Co.; first becoming treasurer, later vice-president and finally president, in which capacity he served until his death. In the early years of the firm he engaged personally in engineering details, but the increase in magnitude of the work undertaken soon rendered this impossible and he turned his attention to the larger questions of organization. At the same time, however, he always kept in close touch with all the engineering work through constant consultation with the engineers in direct charge.

Mr. Kerr possessed exceptional ability for organization and had the power to bring together groups of strong men and inspire them with his progressive spirit, so that they might work together strenuously and effectively toward some desired end.

In spite of his active engineering interests, Mr. Kerr found time to engage in many outside enterprises. He took more than a sporting interest in yachting and was a prominent member of the New York Yacht Club. He was also a trustee of Cornell University and held membership in the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Canadian Society of Civil Engineers and the Franklin Institute, besides a number of social and athletic organizations. Mr. Kerr leaves a widow and four children.

PERSONAL

Robert F. Carr, president of the Dearborn Drug and Chemical Works, sailed May 10 for a three months' tour of Europe.

Asher Walter, formerly manager of the packing division of the H. W. Johns-Manville Company, is now manager of the packing department of Robert A. Keasbey Company, New York City.

E. J. Du Bois, formerly marine salesman with the Anchor Packing Company, and also late of the Bird Archer Company, is now connected with the packing sales department of Robert A. Keasbey Company, New York City.

Core S. Taylor, formerly manager of the packing department of the Peerless Rubber Manufacturing Company, has been appointed general manager of the Commercial Rubber Manufacturing Company, 17 Park Row, New York City.

Prof. Victor Dwelshauvers-Dery, a biographical sketch of whom was published in POWER on pages 281-2, of February 8, writes us an earnest disclaimer that he is cousin of Charles Darwin, as stated. Referring to our authority for the statement, we find that another man was there alluded to as cousin of Charles Darwin, but in a manner which led to

the assumption that the reference was to Professor Dery himself.

J. R. McColl, formerly in the engineering department of the American Blower Company, has tendered his resignation to take effect as soon as the necessary changes in the organization can be satisfactorily effected. He becomes a member of the firm Ammerman, McColl & Anderson, successors to the engineering firm of Brush, Anderson & Ammerman, Penobscot building, Detroit, Mich. For about five years Mr. McColl has had charge of the engineering end of the heating and ventilating department and since the American Blower Company consolidated with the Sirocco Engineering Company, he has specialized on mine ventilation.

SOCIETY NOTES

The Kentucky State National Association of Stationary Engineers' convention is to be held the first Friday and Saturday in June (June 3 and 4), not June 10 and 11, as we were previously informed.

At the April meeting of the Council of the American Society of Mechanical Engineers, the Executive Committee reported as the total booking on the "Celtic" to date of those who will attend the joint meeting in England, 144 members and ladies; going by other routes or already in Europe, 81, making a grand total of 225. At the same meeting it was voted that the Council accept the invitation of the National Steam and Hot Water Fitters' Association to a conference leading to the adoption of uniform standards for flanged and screwed cast-iron fittings, and that the secretary communicate with the various members of the council and specialists in power-house practice, and ask their suggestions for names for such a committee. It was also voted that Charles Whiting Baker be appointed chairman of a committee with power to increase the number to investigate the matter of a proposed bill now before the legislature to license engineers and report to the council at its next meeting.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c each. Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

FLUID MOTOR. William J. Morrison, Pittsburg, Penn. 955,896.

ROTARY ENGINE. Howard M. Van Alstyne and Walter Bell, Rensselaer, N. Y. 955,925.

STEAM TURBINE. John Melville, Angeles Camp, Cal., assignor of one-fourth to Peyton V. Goodloe, Angels Camp, Cal. 955,124.

CRUDE-OIL ENGINE. John M. Primm, Vanburen, Ind., assignor to the Primm Oil Engine Company, Vanburen, Ind., a Corporation of Indiana. 955,169.

WATER MOTOR. William G. Stowell, Dayton, O., assignor to the W. G. Stowell Company, Dayton, Ohio, a Corporation. 956,225.

INTERNAL COMBUSTION ENGINE. Abner W. Nichols, Augusta, Me., assignor to Cushnoc Motor Company, Augusta, Me., a Corporation of Maine. 956,405.

INTERNAL COMBUSTION ENGINE. Robert M. Roof, Muncie, Ind., assignor of one-third to Frank E. Hill, Muncie, Ind. 956,423.

BOILERS, FURNACES AND GAS PRODUCERS

BURNER. Samuel C. Hix, Memphis, Tenn. 956,094.

GAS PRODUCER. Samuel B. Sheldon, South Bethlehem, Penn. 965,199.

STEAM BOILER. Justin M. Lord and Charles H. Jones, St. Johnsbury, Vt. 956,383.

WATER-TUBE BOILER. Carl Mahlke, Mödling, near Vienna, Austria-Hungary, assignor to the firm, Röhrenkesselfabrik Mödling, vormals Dürr, Gehre & Co., Aktiengesellschaft, Mödling, Austria-Hungary. 956,388.

POWER PLANT AUXILIARIES AND APPLIANCES

IGNITION TIMBER. Herman J. Broedling, Dayton, Ohio. 955,845.

VAPOR BURNER. Emmet B. Raymond, Los Angeles, Cal. 956,417.

VALVE. Thaddeus Galvin, Detroit, Mich., assignor to Galvin Brass Company, Detroit, Mich., a Corporation of Michigan. 955,859.

HOLLOW SHAFT PACKING. Harry Gray and James A. Kenyon, Rawtenstall, England. 955,867.

BOILER-TUBE CLEANER. Richard W. Hamann, St. Louis, Mo., assignor to Eugene J. Feiner, St. Louis, Mo. 955,870.

FLAP CHECK VALVE. George Woodall, New York, N. Y. 955,931.

VALVE. Sidney Davis, Lankershim, Cal. 955,948.

PUMP. Ernst Gerstenberg, Washington, D. C., assignor to the Deis Pump Company, Washington, D. C., a Corporation of the District of Columbia. 955,960.

PRESSURE-REDUCING DEVICE FOR HIGH-PRESSURE BOILERS. Joseph C. Mirick, Pueblo, Colo. 955,977.

OIL PUMP. Eugin Woerner, Cannstatt, Germany. 956,016.

TRAP. Herbert G. R. Bennett, Youngstown, Ohio. 956,030.

CARBURETING APPARATUS. Robert C. Dawson, Wampum, Penn., assignor of one-half to Harry Bartow, Deanor, Penn. 956,048.

PUMP VALVE. Charles Dickinson, Maricopa, Cal. 956,050.

GAS-ENGINE IGNITER. George Gray, Mianus, Conn., assignor to Mianus Motor Works, Mianus, Conn., a Corporation of Connecticut. 956,075.

COUPLING. Edwin T. Greenfield, Kiamesha, N. Y. 956,076.

COUPLING. Edwin T. Greenfield, Kiamesha, N. Y. 956,077.

CYLINDER PISTON. Eli W. Phillips, Boston, Mass., assignor to American Tool and Machine Company, Boston, Mass., a Corporation of Massachusetts. 956,163.

GASKET. William A. Schulttheis, Cincinnati, O. 956,188.

CONDENSER. Charles J. Snow, Lansdowne, Penn. 956,210.

STEAM CONDENSER. Charles J. Snow, Lansdowne, Penn. 956,211.

REDUCING VALVE. Arthur W. Cash, Newark, N. J. 956,283.

CUTOFF FOR FLUID-PRESSURE MOTORS. Joseph H. Champ, Cleveland, Ohio. 956,287.

MISCELLANEOUS TOOLS

WRENCH. Reuben Miller, Jr., Pittsburg, Penn. 955,893.

WRENCH. John R. Long, Warren, Penn., assignor to William R. Rogers, James P. Rogers and A. A. Printz, Warren, Penn. 955,974.

WRENCH. Andrew O. Semsmon, Everett, Wash., assignor of three-fourths to W. J. Lamrick, George Olson and Thomas Semsmon, Everett, Wash. 956,197.

SPANNER WRENCH. George Amborn, New York, N. Y., assignor to J. H. Williams & Co., Brooklyn, N. Y., a Corporation of New York. 956,259.

WRENCH. George Bryar, Boston, Mass., assignor to Franklin Playter, Boston, Mass. 956,280.

COMBINATION WRENCH. George E. Anderson, Chicago, Ill. 956,467.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City. Spring meeting at Atlantic City, May 31 to June 6.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff, Denver, Colo.; sec. and treas., Frank M. Tait. Association York. Next annual convention, St. Louis, Mo., May 23-28.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railway, Cleveland, O.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., L. B. Stillwell; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City. Next semi-annual meeting, St. Louis, Mo., June 30 and July 1, 1910.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August 2-5, 1910.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia Pa., Next convention, Philadelphia, Pa., June 6-10, 1910.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, St. Louis, Mo., January 16-21, 1911.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio. Next meeting, Cincinnati, May 19 and 20, 1910.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. E. Brown; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Niagara Falls, Canada, May 24-27, 1910.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee, 606 Main St., Peoria, Ill. Next convention, Denver, Colo., September, 1910.

NATIONAL DISTRICT HEATING ASSOCIATION.

Pres., A. C. Rogers, Toledo, O.; sec. and treas., D. L. Gaskill, Greenville, O. Next annual meeting at Toledo, O., May, 1910.

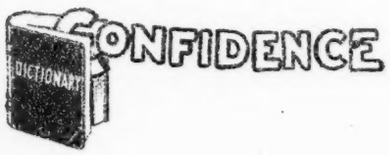
Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power and the Engineer.

"After all, advertising is but the supreme expression of a manufacturer's confidence in his product."

That paragraph was written by a man who has distinguished himself in fields of writing other than that of advertising.

And in a single sentence he has conveyed a whole lesson for both seller and buyer.



"Confidence" is one of the biggest words in the English language.

Folks are willing to travel at the rate of sixty miles an hour mainly because they have confidence in the man at the throttle.

We work every day over a battery of boilers that are capable of blowing us to kingdom come, confident that the engineer in charge knows his business.

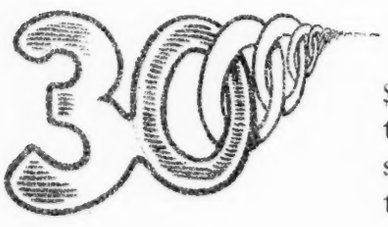
Manufacturers invest great sums in plant and equipment, confident that the investment will pay.

The live wires among them advertise extensively, confident that the advertised article will make good.

And advertising is the supreme expression of their confidence.

"Money talks"—$6,000 for a single insertion of a single advertisement in a single magazine is a common occurrence.

Does the advertiser feel confident of getting that money back as a *direct* result of that one advertisement?



Hardly. If he's selling something at $100 each and thirty orders result, the advertisement has paid.

Because those thirty buyers are going to recommend the article to thirty others, and they to thirty others—a sort of endless chain is started.

Yet that advertisement would have been a criminal waste of money had the writer of it lied and had the goods failed to live up to claims.

Every possible booster would have become the old original knocker and the advertiser would have received a blow hard to recover from—

That is, only folks with the right sort of product and a measureful of confidence in it pay money to express it in print where the public may read and learn.

And it is likewise why the fake and swindler are learning to stay out of the searchlight of publicity.

"It pays to advertise" only when you can back your claims and give the public a square deal.

That is as certain as time, tide and taxes, and by the same token is the reason why you buyers can read advertisements, believe in them and buy from them with *confidence*.

An advertisement in a reliable paper is a protection and insurance.

Don't mistake us—there are many reliable concerns whose advertising is as weak as diluted water.

There are others who do not advertise at all.

But the whole-hearted, vigorous, virile advertiser of his wares comes before you, makes certain claims in public and must live up to them always or be broken on the wheel of public criticism and ostracism.

So, the first requisite for successful advertising is *confidence* in the goods.

The second is to tell the truth about things.

Fundamental principles, these. The advertisers in POWER believe in them and base their claims on them.

Let the readers in POWER believe in the advertisers—mutual *confidence* will *pay* both.